

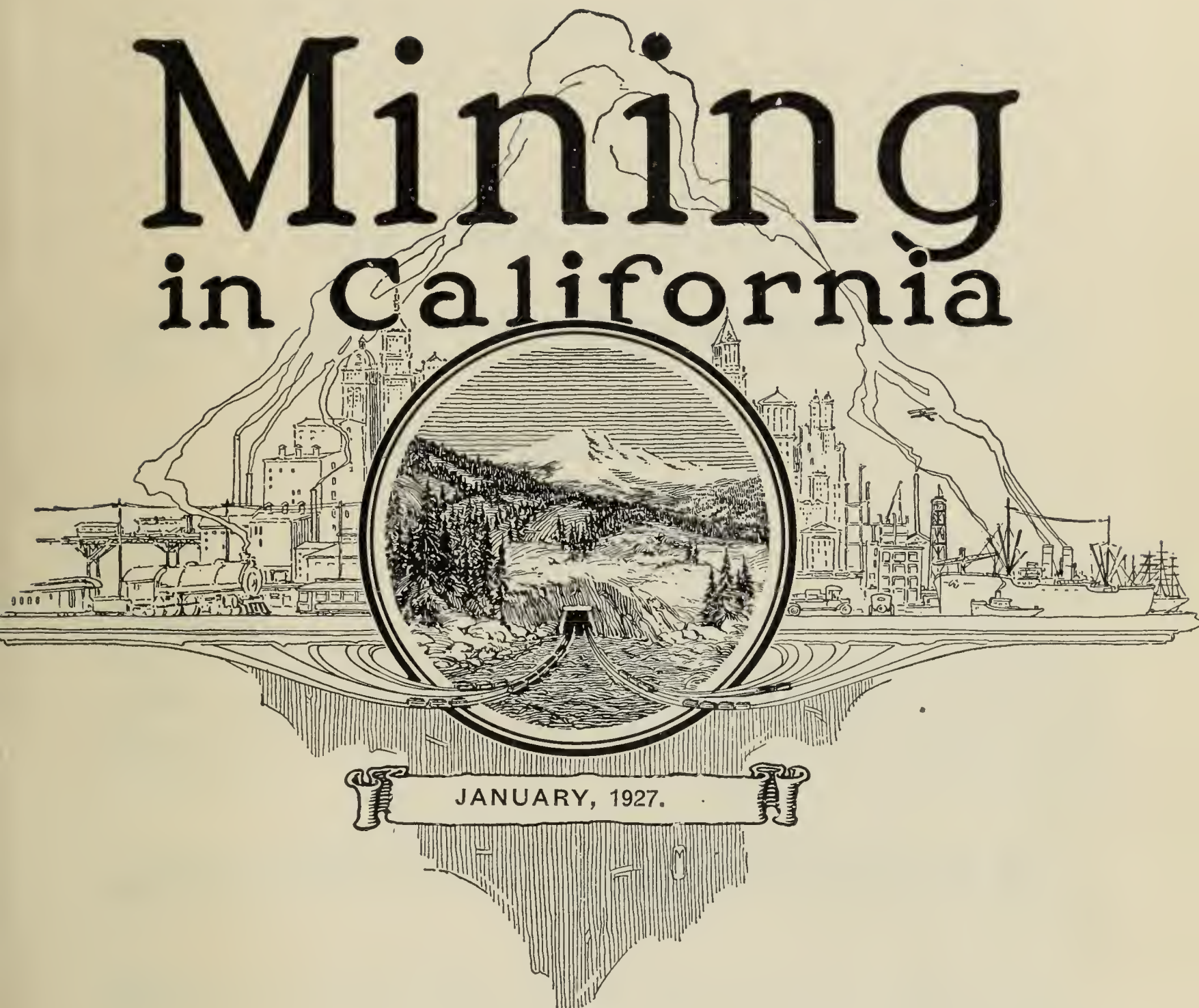


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Mining in California



JANUARY, 1927.

PUBLISHED QUARTERLY
CALIFORNIA STATE
MINING BUREAU

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CALIFORNIA STATE MINING BUREAU

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R. D. BUSH, State Oil and Gas Supervisor	-	-	-	-	-	-	San Francisco
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NOTE.—A detailed report of the activities of the Department of Petroleum and Gas is issued monthly by the State Mining Bureau, entitled 'Summary of Operations, California Oil Fields.'

CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT

State Mineralogist

Vol. 23

JANUARY, 1927

No. 1

CHAPTER OF

REPORT XXIII OF THE STATE
MINERALOGIST

COVERING

MINING IN CALIFORNIA

AND THE

ACTIVITIES OF THE STATE MINING BUREAU



CALIFORNIA STATE PRINTING OFFICE
CHARLES A. WHITMORE, State Printer
SACRAMENTO, 1927

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CALIFORNIA STATE MINING BUREAU
LLOYD L. ROOT
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE
0 50 100 Miles



- LEGEND -
- Mining Division Boundaries
 - Mining Division Offices.

PREFACE.

The State Mining Bureau is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

The weak point in work of this character has been that the results of field investigations were so long in preparation that they had lost much of their usefulness by the time they finally appeared in print.

As a progressive step in advancing the interests of the mineral industry, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923.

Owing to a lack of funds for printing, quarterly publication was begun in September, 1923.

For the same reason, beginning with the January, 1924, issue, it has been necessary to charge a subscription price of \$1 per calendar year, payable in advance; single copies, 25 cents apiece. 'Mining in California' will continue to be sent without charge to our exchange list, including schools and public libraries, as are also other publications of the State Mining Bureau.

Pages are numbered consecutively throughout the year and an index to the complete reports is included annually in the closing number.

Such a publication admits of several improvements over the old method of procedure. Each issue contains a report of the current development and mining activities of the state, prepared by the district mining engineers. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance also are reported.

While current activities of all descriptions will be covered in these chapters, the Bureau will not discontinue its practice of issuing from time to time technical reports on special subjects. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters will be subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Mining Bureau is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

DISTRICT REPORTS OF MINING ENGINEERS.

In 1919-1920 the Mining Department was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively.

This move brought the Bureau into closer personal contact with operators, and it has many advantages over former methods of conducting field work.

To continue this system most effectively with the limited funds available, for the present biennium, the Redding and Auburn field offices were consolidated and moved to Sacramento on June 1, 1923.

The boundaries of each district were adjusted and the counties now included in each of the three divisions, and the locations of the branch offices, are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the district engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the state's oil fields is included under this heading.

New County Reports.

The series of separate reports on the mines and mineral resources of the different counties, that together comprise the State Mineralogist's Reports XIV to XVII, inclusive, in the case of many of the counties have become exhausted. Those still in stock are in need of revision. It has been thought advisable, therefore, beginning with the January, 1925, issue of 'Mining in California,' to make the district engineers' reports in the form of a complete general report on the mines and mineral resources in one or more of the counties in each district.

This program will be followed as near as possible in succeeding numbers of the quarterly until each county in the state has been covered.

SACRAMENTO FIELD DIVISION.

C. A. LOGAN, Mining Engineer.

On account of unfinished field work, there is no report from the Sacramento Field Division in this issue.

SAN FRANCISCO FIELD DIVISION.

C. MCK. LAIZURE, Mining Engineer.

CONTRA COSTA COUNTY.

Introduction:

When Contra Costa County was originally created in 1850 it included besides its present area about two-thirds of what is now Alameda County.¹ It extended as far south as Alameda Creek, and Santa Clara County adjoined it on the south. The southern third of Contra Costa County and a portion of Santa Clara County were together organized as Alameda County in 1853. Since then its boundaries, except for slight changes in definition, have remained as they are today.

Geography and Topography.

Contra Costa is one of the East Bay counties, bounded on the west and north by the waters of San Francisco, San Pablo and Suisun Bays and San Joaquin River. At the junction of the Mokelumne River with the San Joaquin, the county line turns in a southerly direction and follows the Old River channel nearly due south to Cooney Island, separating Contra Costa from San Joaquin County on the east. From Cooney Island the southern boundary, separating it from Alameda County, runs a little south of west in a straight line to the summit of Divide Ridge just north of Dublin Canyon, thence northwesterly along the summit of the Berkeley Hills to El Cerrito and down El Cerrito Creek to the Bay.

The county has an area of 714 square miles, about half of which is under cultivation. Its population is 53,889 (1920 census). Industry, agriculture, stock raising, and to a lesser extent mining contributes to the prosperity of this area. The county is traversed by both the Southern Pacific and the Santa Fe railroads, which closely follow the water front throughout its length. A branch of the Southern Pacific passes through the central (San Ramon) valley section, connecting Avon on the coast with Livermore, Alameda County, via Walnut Creek and Danville. The electric line of the Oakland, Antioch and Eastern Railroad also traverses the county in a northeasterly direction.

Its industrial and shipping activities are extensive. The county has approximately 70 miles of deep water front on which are located nine port cities: Richmond, Selby, Crockett, Port Costa, Martinez, Avon, Bay Point, Pittsburg, and Antioch. Richmond is the largest city and Martinez the county seat. Among the more important manufacturing plants, chemical and industrial works, allied with the mining industry and in many cases buyers and users of raw mineral products are the following:

At Antioch:

Paraffine Companies, Inc.

At Avon:

Associated Oil Co. (refinery).

¹ Coy, Owen C., California County Boundaries, California Historical Survey Commission, Berkeley, 1923.

At Bay Point:

Pacific Alloy and Steel Co.

At Crockett:

California and Hawaiian sugar refinery.

At Giant:

Giant Powder Co.

At Hercules:

Hercules Powder Co.

At Martinez:

Mountain Copper Company (smelter, sulphuric acid and fertilizer plant).

Shell Oil Co. (refinery).

At Oleum:

Union Oil Co. (refinery).

At Pittsburg:

National Chemical Co. of Cal.

Great Western Electro-Chemical Co.

General Chemical Co.

Pioneer Rubber Mills.

Columbia Steel Corporation.

Johns-Manville Co.

At Richmond:

Santa Fe Foundry Co.

Stauffer Chemical Co.

Wheeler-Reynolds Chemical Co.

Certain-teed Products Corp.

Pacific Sanitary Manufacturing Co.

Standard Oil Co. (refinery).

At Selby:

American Smelting and Refining Co. (smelter).

At Stege:

Union Superphosphate Co.

Topographically, Contra Costa County is distinguished by containing the most prominent land mark in the central coast counties, Mt. Diablo, which rises to an elevation of 3849 feet above sea level. This peak is in the eastern of the two main ridges of the Coast Range Mountains, which strike northwesterly across the county. The western ridge lies close to the coast. Its crest is more regular but its highest peaks are less than 2000 feet in elevation. The western flank slopes gently toward San Francisco Bay. Between the eastern and western ridges lies San Ramon valley, drained by San Ramon Creek, which flows northward into Walnut Creek and hence into Suisun Bay. Marsh Creek rises on the eastern slope of Mt. Diablo and flows northeasterly into the San Joaquin River. These are the two principal streams in the county. The north-eastern corner of the county is included in the delta area of San Joaquin valley and is elevated only slightly above sea level.

CONTRA COSTA

Year	Brick		Coal*		Lime	
	M.	Value	Tons	Value	Barrels	Value
1894			35,000	\$94,000		
1895			48,635	139,655		
1896	150	\$4,500	44,892	118,709		
1897			39,267	105,180		
1898	5,000	25,000	47,000	113,340		
1899			53,013	131,613		
1900			51,248	145,000		
1901			35,000	100,000		
1902	800	11,600	13,960	31,160		
1903	2,600	16,000			5,300	\$4,500
1904	9,385	67,495			12,187	10,359
1905	10,979	73,948			20,244	13,925
1906	23,267	169,022				
1907	48,573	403,564			1,413	1,413
1908	55,844	335,737				
1909	41,033	268,122			14,062	15,468
1910	30,284	199,079			17,338	14,750
1911	36,463	271,575			11,872	8,645
1912	32,621	283,718			14,870	12,640
1913	30,411	212,953			150,551	127,968
1914	16,064	129,543	67	268	5,666	4,724
1915	14,915	139,862	2			
1916	16,672	148,730	2			
1917	and tile	172,653	2			
1918	and tile	148,831				
1919		2				
1920	13,608	312,398				
1921		2				
1922	and tile	307,749				
1923		2				
1924	and tile	327,225				
1925		2				
Totals		\$4,029,304	2368,082	\$978,925	253,503	\$214,392

¹Includes crushed rock, rubble, rip-rap, sand, gravel.

²See under 'Unapportioned.'

³Estimated.

*Coal mining began in the Mount Diablo section of Contra Costa County at least as early as 1861, but there are no segregated county figures available earlier than those here shown. For 1867-1882 (inc.), there are records which indicate for the Mount Diablo field a total of approximately 2,500,000 tons, valued at \$14,300,000.

COUNTY, 1894-1925.

Limestone		Mineral water		Miscellaneous stone ¹ , value	Miscellaneous and unapportioned		
Tons	Value	Gallons	Value		Amount	Value	Substance
		7,600	\$3,700	\$9,000	1,400 tons	\$2,200	Pottery clay.
		5,000	1,200				
		9,300	3,100				
		10,000	3,500				
		12,000	1,900				
		12,000	1,900				
		31,200	8,736		31,700 lbs.	3,645	Copper.
18,000	\$22,500	78,000	19,500				
34,800	43,500	78,000	19,000	23,060			
		²		76,120			
				75,025			
22,038	43,038			210,250	2,057 tons	21,870	Asphalt.
9,140	18,282	109,400	5,470	236,047	9,500 tons	123,500	Asphalt.
					6,000 tons	7,500	Pottery clay.
22,556	42,837	199,800	10,590	233,782	17,085 tons	222,105	Asphalt.
						683,392	Unapportioned, 1900-1909.
22,912	37,064	2,500	375	235,655			
68,708	46,208	206,500	10,325	257,503			
25,879	45,291	200,000	10,000	478,162			
26,259	34,976	192,292	4,989	660,405		921,349	Other minerals.
32,657	43,661	364,288	3,643	308,727		658,755	Other minerals.
11,989	14,565	³ 350,000	4,000	397,330		757,748	Asbestos, cement, coal.
²		351,724	6,154	363,753		760,423	Cement, clay, coal, limestone.
		436,265	8,563	322,507		772,934	Cement and coal.
		30,376	3,038	324,884	100 tons	300	Pottery clay.
						847,198	Cement and copper.
		²		275,309		193,340	Clay and clay products.
						926,909	Cement and mineral water.
				432,654	1,743 tons	3,319	Pottery clay.
						1,333,682	Cement and mineral water.
		600,300	6,099	415,127		198,248	Clay and clay products.
						1,003,258	Other minerals.
				559,915	7,086 tons	12,910	Pottery clay.
						1,516,738	Cement, limestone, mineral water.
				629,216		281,743	Clay and clay products.
						1,761,985	Cement, limestone, mineral water.
				646,369		1,374,496	Clay (pottery), cement, limestone, mineral water.
				708,159		1,836,020	Clay (pottery), and clay products, cement, limestone, mineral water.
² 294,938	\$391,922	² 3,286,545	\$135,782	\$7,878,959		\$16,225,567	

Geology.

That portion of the Coast Range within Contra Costa County has been studied in detail by the Department of Geology and Paleontology of the University of California, and the southwestern portion has been mapped by Lawson.¹ A detailed list of references will be found in State Mining Bureau Bulletin 72, Geological Formations of California.

A nearly complete section of the Coast Range formations from the Franciscan to the Recent are exposed within the county, but as the area is one of many faults, no single formation is continuous over a large area. The most abundant strata are sandstones and shales of Cretaceous and Tertiary age.

MINERAL RESOURCES.

Contra Costa County contains no great variety of commercial minerals. It is particularly lacking in deposits of valuable metals, but on the other hand its structural materials on account of their easy accessibility and proximity to the cities surrounding San Francisco Bay are important natural resources. Its latent coal deposits, which were once the most productive in the state, are also of potential value. The most important minerals now produced are: cement, miscellaneous stone (crushed rock, sand, and gravel) and brick. Pottery clay, limestone, mineral water, and foundry sand are also on the commercial list. Other mineral resources include asbestos, coal, copper, diatomaceous earth, manganese, and quicksilver. Among those whose occurrences are probably only of mineralogical interest are fluorite, selenite, opal, talc, and numerous other rock-forming minerals.

The last general report upon the mineral resources of Contra Costa County is contained in State Mineralogist's Report XVII, 1920. In order to bring these data up to date in conformity with the new series of county reports begun in 1925, the writer visited the county in the latter part of January, 1927. All new developments and changes noted in the status of the industry are included herein.

The total value of minerals produced is unknown, as no segregated county figures are available prior to 1894. Records show, however, that coal alone to the value of at least \$14,000,000 was taken out during that time. From 1894 to 1925, inclusive, approximately \$30,000,000 in mineral wealth has been produced. In 1925 Contra Costa County ranked eighteenth among the fifty-eight counties in the state, with a mineral output valued at \$2,544,179. The accompanying table gives the total recorded output from 1894 to 1925, inclusive.

ASBESTOS

In the so-called Diablo Mining District in Contra Costa County, mainly lying in T. 1 N., R. 1 W., and T. 1 N., R. 1 E., there have been noted occurrences of chalcopyrite, barite, cinnabar, fluorite, selenite, opal, chromite, manganese, asbestos, and other minerals. Some of these deposits occur on privately-held lands; mining claims have been located on other discoveries, beginning at an early date, but most of the deposits have proved to be superficial.

¹ Lawson, A. C., U. S. Geol. Survey, San Francisco, Folio 193.

A. Drumeller located some claims in 1925 on an asbestos deposit, described as being eight miles easterly from Clayton. The locality was not visited.

Bibl: State Mining Bureau Bull. 91.

BRICK AND TILE

Bricks have been produced in this county since 1896, if not earlier. In recent years building, roofing and art tile have been added to the output. Although a number of plants formerly in operation have ceased to exist, all of these products are now important items in its mineral industry.

California Art Tile Co. This company has a large plant on Hout's Spur of the Southern Pacific Railroad at Twenty-seventh and Main Streets, Richmond, where it manufactures Faience tile, Moorish tile



Plant of California Art Tile Company, Richmond, Contra Costa County

and other ornamental art tile. J. W. Hislop is president; L. J. Hislop, secretary; W. A. Hislop, plant chemist, and C. E. Cummings, superintendent. Operations began in April, 1922, and have since been continued without interruption.

Clay from Lincoln, Placer County, and sand from Ione, Amador County are among the crude minerals utilized. Glaze materials are obtained in the east. The plant is equipped with four round down-draft kilns, each of 8000 square feet capacity. Oil is used for burning. An average of 30 men are employed.

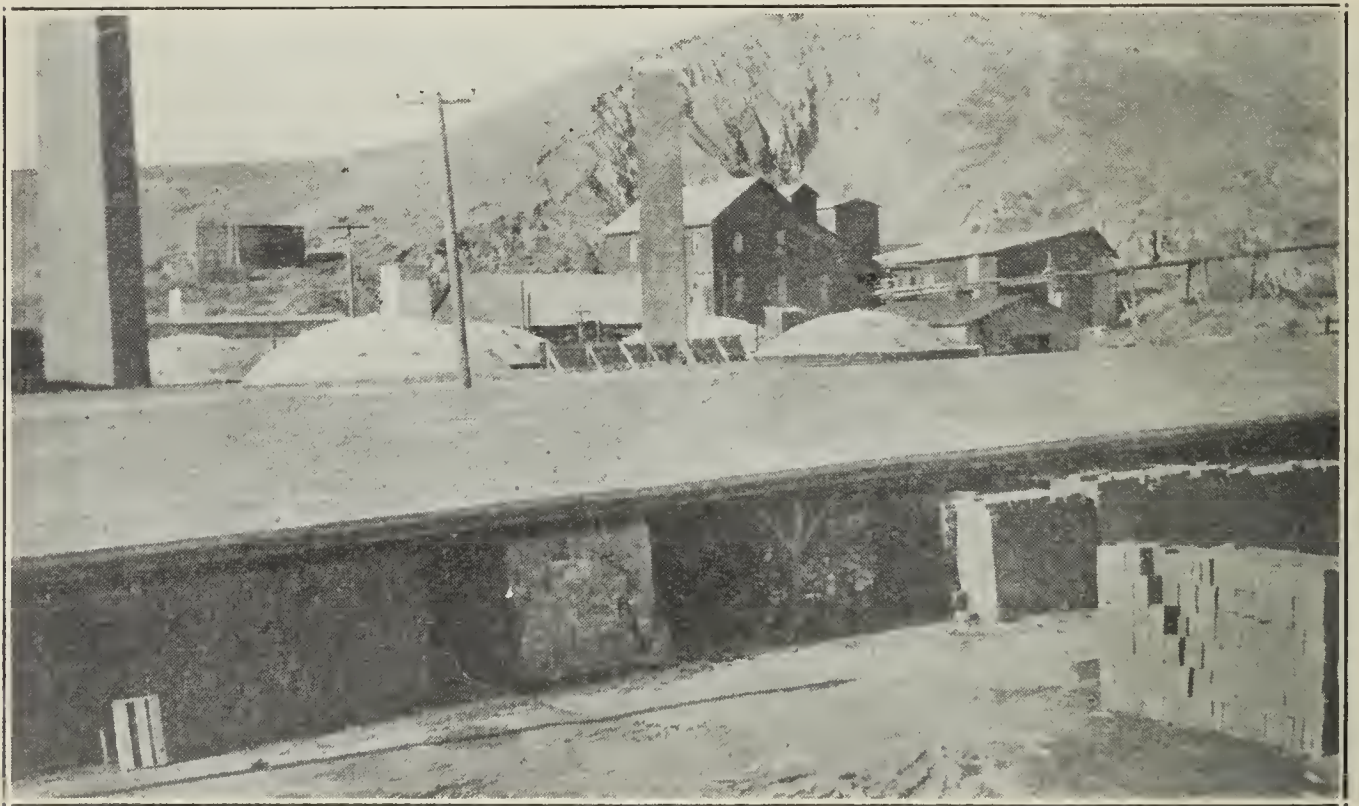
Mastercraft Tile And Roofing Co. Office, No. 1, Twentieth Street, Richmond; C. V. and F. A. Mero, owners. Cement roofing tile has been manufactured by this company for the past four years at its Richmond plant. During the past year hand-molded clay roofing tile has been added to their line. The clay tile plant is located on San Pablo Canyon road, near San Pablo, but the clay is obtained near Richmond.

Burning is done in a rectangular down-draft kiln using oil for fuel. Six men are employed.

Port Costa Brick Works. This plant is situated three-quarters-of a mile east of Port Costa on the shore of Carquinez Straits. C. G. Berg, president; W. S. Hoyt, secretary; home office, 808 Sharon Building, San Francisco. Their products are common red brick and hollow building tile.

The raw material used is obtained from a high blue-shale bank 1500 feet from the water front. The shale is blasted down and loaded by a $1\frac{1}{2}$ -yard electric shovel into $5\frac{3}{4}$ -yard hopper-bottom side-dump cars. These are hauled to the plant by a gas tractor, fitted with flanged wheels, or by an electric third rail system, as desired.

The stiff-mud process is used. Equipment includes a Hoffman continuous kiln and 11 field kilns, with a capacity of 400,000 brick for each type, giving the plant a maximum output of 60,000 brick and



Richmond Pressed Brick Co.'s plant; clay quarry in background. Point Richmond, Contra Costa County.

60 to 100 tons of hollow tile per day. Both open-air or artificial drying with heated air is used, according to conditions. The dryer has a capacity of 40,000 bricks or their equivalent in tile. Petroleum coke is used for fuel in the Hoffman kiln. About 2000 tons are consumed per year, and it is said to be very satisfactory. Fuel oil to the amount of 15,000 to 20,000 barrels per year is used in the field kilns. Electric power from the lines of the Great Western Power Co. is supplied throughout the plant. There is a connected load of about 900 horsepower, but only 400 is used at present. Fifty to sixty men are employed.

Bibl: State Mineralogist's Report XVII, p. 50.

Richmond Pressed Brick Co. The plant was erected by the Los Angeles Pressed Brick Company, but it became an independent company in 1921. It is situated at Point Richmond, near the Santa Fe-San Francisco ferry terminal, and is served by a spur track of the

Santa Fe railroad. S. W. Smith, president; W. S. Hoyt, secretary; F. M. Irving, plant superintendent; home office, Sharon Building, San Francisco. The output includes pressed brick, fire brick, face brick, paving brick, and floor tile.

For the light-colored and buff brick a portion of the raw materials used include clay and sand shipped in from Ione and Lincoln, as well as some sand from Antioch. Clay shale from the pit adjoining the plant is used for making dark-red brick. As the bank is high, the material drops to a loading bin after blasting. From here it is trammed a short distance in cars to the plant, which is equipped with a stiff-mud machine, capacity 100,000. Other equipment includes a Boyd brick press, capacity 16,000; and six 36' down-draft kilns. Electric power is used to operate the plant and crude oil for burning. Fifty-five men are employed.

Other Companies.

Among the former brick companies that have ceased operations in the county are:

Mt. Diablo Pottery and Paving Brick Co.
Carquinez Brick and Tile Co.
Coast Firebrick Co.
Holland Sandstone Brick Co.
Diamond Brick Co.
Golden Gate Sandstone Brick Co.
Richmond Brick Co.
Gerlack Brick Co.

CEMENT.

Portland cement is the most important single structural material in the mineral output of the state. Eleven plants are now operating in nine counties. The presence of a large modern cement plant in Contra Costa County adds greatly to the rank of this county in respect to mineral production as cement exceeds all other mineral products of the county in annual value of output.

Cowell Portland Cement Co. S. H. Cowell, president; W. H. George, secretary and general manager; home office, No. 2 Market Street, San Francisco; C. D. Barnett, superintendent of plant, Cowell, California. Two products are made, 'Mt. Diablo' brand portland cement and 'Mt. Diablo' waterproof cement, manufactured under patents of the Pantheon process.

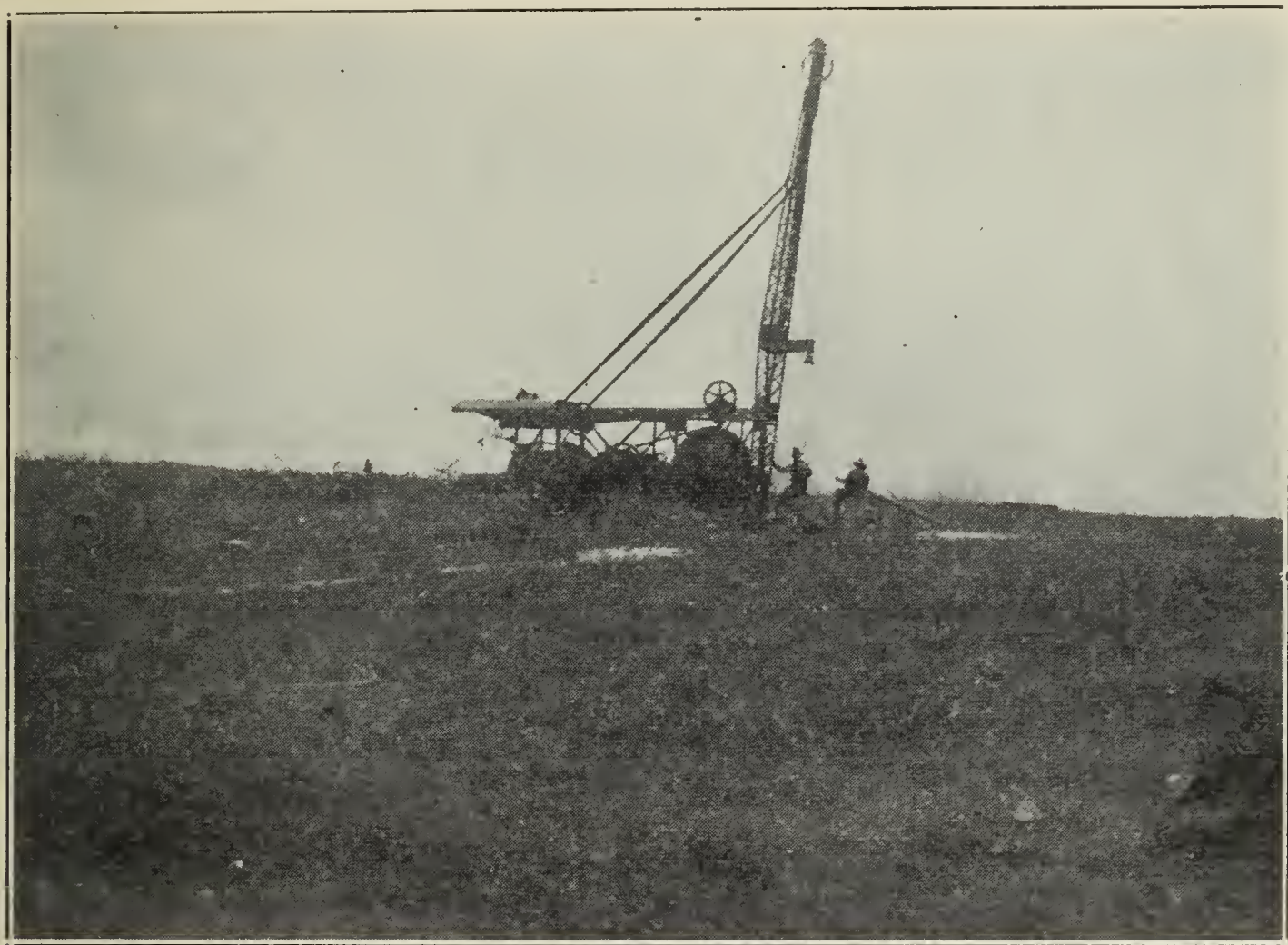
The plant is situated in Cowell at the base of Lime Ridge, about 10 miles southeast of Bay Point. It is connected by the Bay Point and Clayton Railroad, a standard-gauge line, with both the Southern Pacific and the Santa Fe lines at Bay Point. There is a good road from the highway at Concord, to Cowell. The quarries from which the limestone and clay are obtained are situated along the ridge back of the plant. The limestone occurs in irregular bodies along the Mt. Diablo fault, and is unique in being of algae formation and of such large size. An Armstrong all-steel well rig is used for advance prospecting, and deep-hole drilling for blasting. Large shots are used, the holes being loaded with 5% R. R. P. and 40% dynamite for priming. A Marion M. 37 electric shovel with 1 $\frac{3}{4}$ -yard bucket, revolving throughout a full



Plant of Cowell Portland Cement Co., at Cowell; Contra Costa County —Mt. Diablo in background. Photo by courtesy of the company.

circle, loads the broken rock into hopper-bottom cars, which are transported by locomotive to the crusher building. Here the rock goes to gyratory crushers, is passed through rotary screens and transported by belt conveyors to the storage bunkers. The crushed materials are drawn from these bunkers into gable-bottom cars and hauled by locomotive to the limestone, and clay and silica bins at the mill.

The raw materials from these bins are delivered by belt conveyors to the dryers. After drying they are taken by pivot bucket conveyors to either ball or swing hammer mills. The mills discharge to belt conveyors, which deliver to proportioning scales where each material is accurately weighed and correct amounts of each mixed together. The mixture is then conveyed to the raw tube mills where it is reduced to proper fineness and then conveyed to bins over the kilns. In the kilns



Armstrong all-steel drill used for advance prospecting and deep-hole blasting.
Cowell Portland Cement Co. Photo by courtesy of the company.

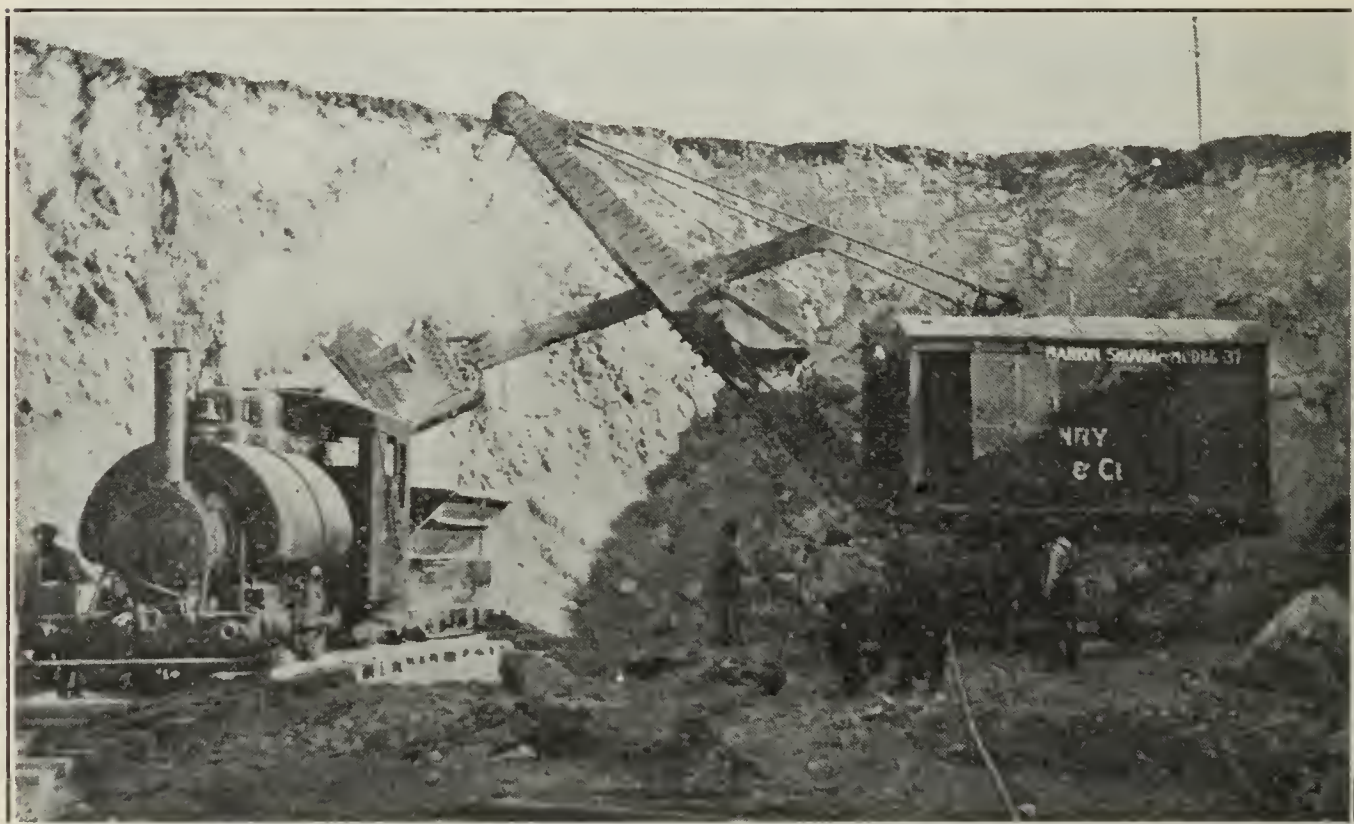
it is sintered or burned to a clinker. The hot clinker is elevated and passed through rotary coolers and then conveyed by belt to the kiln clinker scales. It is weighed and then delivered to the clinker-storage which is under roof and has a capacity of 225,000 barrels. Clinker from any part of the storage space is conveyed to clinker scales where it is weighed and gypsum added from the gypsum scales. The combination is delivered to the finish ball mills and reduced to proper size for final grinding in the finish tube mills to pass standard specifications for fineness. The finished product is then delivered to any one of 40 storage bins of 3000 barrels capacity each. From these storage bins it goes to bins feeding Bates packers where it is sacked, or to barrel packers. In these forms it is loaded on cars or auto trucks. All operations are under strict technical control.

There are eight rotary kilns, $7\frac{1}{4}' \times 110'$ in size; four rotary coolers, $5' \times 60'$; 26 tube mills, as well as ball mills and hammer mills. Each unit is driven by an individual motor operating at 440 V., power being supplied by the Great Western Power Co. It is estimated that one horsepower is required for each barrel of cement produced. The capacity of the plant is 4800 barrels per day. From 200 to 235 men are employed.

Bibl: State Mineralogist's Report XVII, pp. 51-53.

CHROMITE.

Mt. Diablo Development Co., located a number of claims in T. 1 N., R. 1 W., comprising the Mt. Zion Chrome Mine. Some development



Full-revolving type electric shovel loading limestone at quarry face. Cowell Portland Cement Co., Contra Costa County. Photo by courtesy of the company.

work was done but the bureau has no record of any commercial production from the property.

CLAY

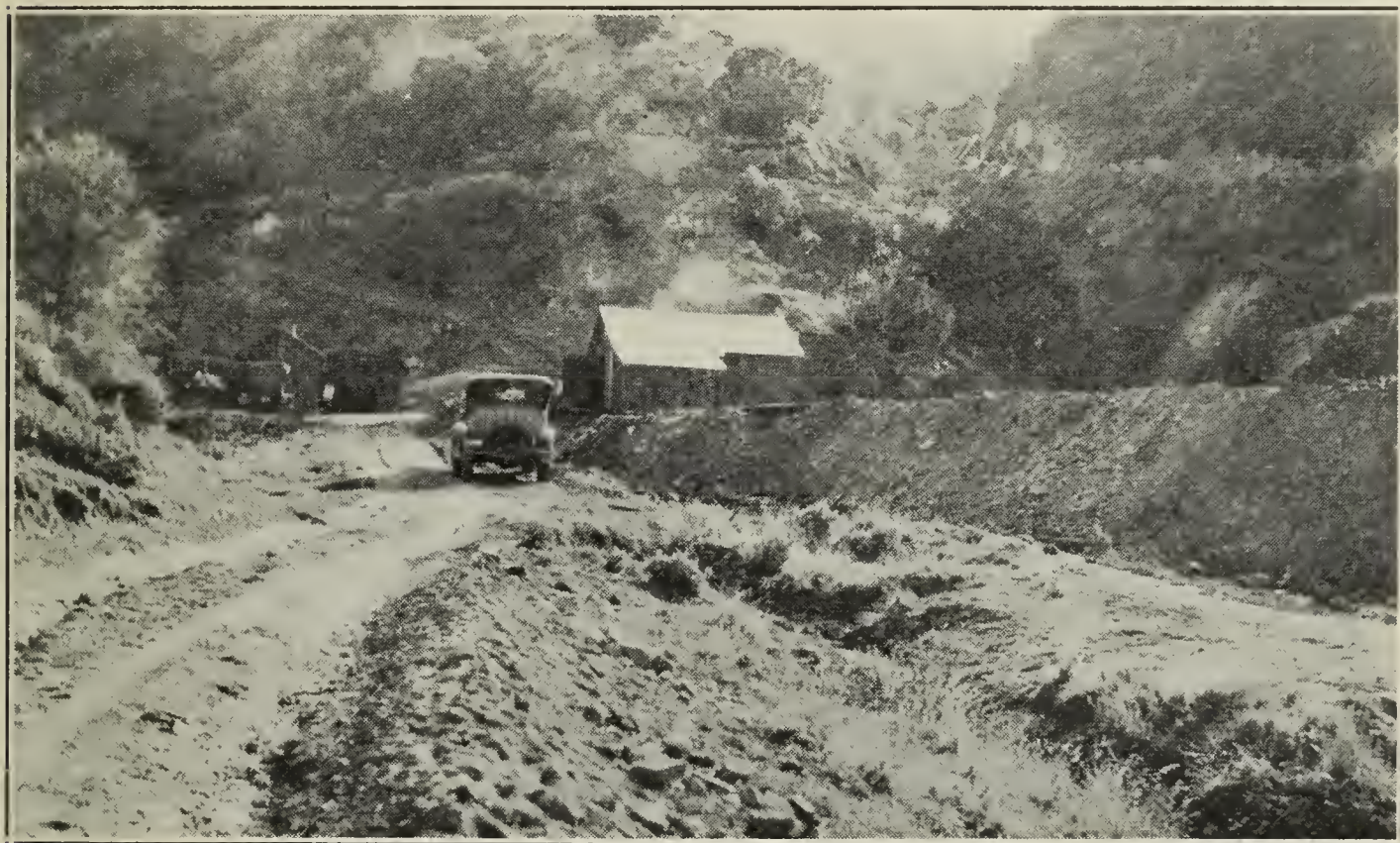
Leaving out of consideration the clay and shale used locally at brick and tile plants in the county, there is practically no clay mining industry, although one company is mining and shipping a clay shale to its plant in Alameda County.

The clay resources of this county have never been thoroughly investigated, but they are undoubtedly of considerable extent and value. Much of the peat and marsh land of the delta region and the flat area bordering on San Pablo Bay is underlain by a smooth, tough, sticky yellow clay. Samples of good plastic clays from this county, some fairly high in alumina, have been received in the bureau laboratory from time to time, but little development has resulted.

Some high grade clays are reported associated with the coal veins in the Mt. Diablo region.

Clark and Sons, N. This company quarries a calcareous clay shale at Walnut Creek and ships the material to their plant in Alameda, where it is used as a filler in pottery work. The shale is mined from a knoll alongside the Southern Pacific Railroad, one-half mile north of the town at Oxley siding. The surface portion of the deposit contains gravel mixed with soil, below which is a bed of clean shale. It is worked as an open cut, the face being about 200 feet wide and 70 or 80 feet in height. The material is taken out during the dry season and stored under roof for shipment. About two cars per week are sent out. When visited, there was no one at the quarry, but a loaded car was on the siding and there was other evidence of recent work.

Bibl: State Mineralogist Report XVII, p. 49; Preliminary Report No. 7, pp. 44-46.



Entry to Black Diamond Coal Mine of Southport Land and Commercial Co., Contra Costa County. The road shown at upper right, going up canyon, leads to sandstone bed mined for molding sand.

COAL.

Coal mining began in the Mount Diablo section of Contra Costa County at least as early as 1861, and the field has been the most prolific producer of any coal area in the state. From 1867 to 1882, inclusive, are records which indicate for the Mount Diablo field a total output of approximately 2,500,000 tons, valued at \$14,300,000. Production practically ceased about 1902.

The coal deposits are found on the northeast slopes of Mount Diablo, about six miles south of Pittsburg. The main productive area extends from Sec. 7, T. 1 N., R. 2 E., westerly to Sec. 4, T. 1 N., R. 1 E., but definite evidence of coal has been found over a belt nearly ten miles in length. The coal belt strikes in a general east-west direction, and the veins dip north at an average angle of about 37°. Several large mines were opened, the leading companies being the Black Diamond Coal Company, the Union Coal Company, and the Pittsburg Coal Company. Two narrow gauge railroads were built into the dis-

trict, one from Pittsburg Landing to Somersville, and one from Antioch to Stewartville. The old buildings and railroads are now dismantled and little remains to indicate the extent of former operations. There are three main veins which have been mined in the principal properties, the uppermost or Clark vein, next the Little vein, and the Black Diamond or lowest. The stratigraphic distance between the Clark and Black Diamond veins varies from 300 to 400 feet. The Clark vein has a thickness of $2\frac{1}{2}$ to 4 feet, being nearly all clean coal with a good firm roof and floor of sandstone. The Little vein is thinner and more irregular, but reaches a width of two feet of good clean coal in places. The Black Diamond vein is much thicker, running from eight to eighteen feet in thickness, but there are many partings of slate and bone, which would have to be separated if the entire vein is mined. Clay gouge occurs along the walls, and on account of its character there is considerable swelling and movement, which add to the difficulty and cost of mining this vein.

Considerable literature has been published on the early coal mining operations in Contra Costa County. The beds have been described particularly by Goodyear¹, and Smith², as well as by others. The principal references are given in the bibliography herewith.

Southport Land and Commercial Company, 573-576 Mills Building, San Francisco; E. S. McCurdy, manager. This company owns several sections of land in the Mt. Diablo field, including the Black Diamond coal mine. For the past year several men have been steadily employed, cleaning out, retimbering and otherwise opening up the old Clayton tunnel. At the time of visit they were in about 1200 feet. The Clayton entry is run south as a crosscut, cutting all three veins. When the Black Diamond vein is reached the gangway turns east and follows the vein. As far as opened up on this level, the workings were dry and most of the timbers in an excellent state of preservation, though showing evidence of movement and crushing in places. The company is reticent as to its plans, but stated that many of the mine maps and records were destroyed in the San Francisco fire and that the work being done is of an exploratory nature to determine the location of old workings and shafts that will afford good ventilation. Air is supplied by a blower at present and a mule is used for tramming.

Modern methods of utilizing coals of this class lead to the belief that commercial production may again result from the work.

Bibl: State Mineralogist's Reports IV, pp. 14, 267; VI, p. 116; VII, pp. 117-146; VIII, p. 160; IX, p. 323; X, p. 165; XI, p. 191; XII, pp. 43, 64; XIII, p. 51; XVII, p. 53; U. S. Geol. Survey 22nd Annual Report, Part III, p. 500; Bull. 285-f; Min. Resources 1883, p. 20; U. S. Bur. of Mines Bull. 22, pp. 53, 395; Mineral Resources West of the Rocky Mountains by R. W. Raymond, 1874, pp. 39-42; Geol. Survey of California, Vol. II, pp. 3-34; Coal Mines of the Western Coast of the United States by W. A. Goodyear, San Francisco, 1877.

¹ Goodyear, W. A., The Coal Mines of the Western Coast of the United States, 1877; State Mineralogist's Report VII, pp. 117-146.

² Smith George Otis, U. S. Geol. Survey 22nd Annual Report, Part III, p. 500.

COPPER.

Chalcopyrite occurs with pyrite, in quartz, on Eagle Peak, Mount Diablo. Copper minerals have also been noted near Mount Zion, T. 1 N., R. 1 W. There was a small output in 1901 and 1918, but none since.

Bibl: State Mining Bur. Bull. 91.

DIATOMACEOUS EARTH.

That beds of diatomaceous earth occur near Pinole has been known for many years. A little of the material has been used in experimental work, but the deposits remain practically undeveloped.

Dohrman Deposit. A bed has been opened up on the property of the H. G. F. Dohrman Estate; address, Miss T. L. Dohrman, 2015 Franklin Street, Oakland. This property comprises 35 acres situated about one mile west of Pinole. It lies adjacent to the highway and is crossed by the Southern Pacific and Santa Fe Railroads. As yet it has not been developed on a commercial scale, but its proximity to the Bay region and excellent shipping facilities by rail or truck give it a potential value if the material is suited for industrial uses. A large quantity is reported to be available.

Pawsey Deposit. John Pawsey, of Pinole, owns six acres on the western edge of the town. The diatomaceous earth is exposed from the base to the top of the hills, indicating a considerable thickness to the beds. The material is cream-colored and rather tough, and was being quarried and used for road filling near Pinole at the time of visit. No technical use has been made of it up to the present.

LIME AND LIMESTONE.

Limestone outcrops conspicuously over a considerable area along Lime Ridge, in T. 7 N., R. 1 W. Burned lime was produced here by the Henry Cowell Lime and Cement Company previous to the erection of the cement plant by the Cowell Portland Cement Company. The Spreckels Sugar Company formerly operated a limestone quarry on the same ridge, about two miles south of the Cowell quarry, the limestone being shipped to the sugar refinery at Crockett and to the Selby smelter. This quarry was closed down in 1915 and their holdings sold to the Cowell Portland Cement Company. In 1924 the Mt. Diablo Lime Marl Company began producing limestone for agricultural purposes.

Mt. Diablo Lime Marl Co. R. L. Fry, president; G. A. Putnam, secretary, Walnut Creek; E. B. Bumstead, treasurer. The company's holdings consist of 51 acres situated on Lime Ridge about five miles northeast of Walnut Creek. The company has a plant for crushing, screening and sacking the ground material. Equipment consists of gyratory crusher, Grindler hammer mill and screens. For agricultural use the lime stone is ground so that 60 to 80% passes 100 mesh. It is hauled by trucks to the Southern Pacific railroad $1\frac{1}{2}$ miles distant or to the San Francisco-Sacramento railroad, one mile distant. Two vertical kilns were placed on the property with the idea of producing burned lime also, but this type of kiln was found unsuited for burning the rock.

L. C. Hopper, Box 615, Concord, California, took the deposit and plant under lease in September, 1926. On account of wet weather, it was temporarily shut down at the time of visit. Four to eight men are employed when operating.

MANGANESE.

Some small bunches of manganese have been found on the south eastern side of Mount Diablo, but no commercial deposits have been developed. Manganese also occurs on Red Rock Island off Point Richmond. The deposit here is described by A. C. Lawson¹ as follows: "The ore occurs on the southwest side of the island as an integral part of the radiolarian chert. The chert here has a west-northwest strike and nearly vertical dip, and consists of the usual rythmical alternation of thin beds of hard, flinty to quartzose chert, and partings of shale, the whole having a reddish color. * * * A belt parallel to the strike of the chert includes interstratified layers of psilomelane, which, by reason of their black color, present a bold contrast to the adjoining rocks. Most of the layers are about one-fourth to one-half inch thick and replace locally the usual shale parting, but in places the psilomelane is much thicker. Some of the layers of the chert adjoining these layers of psilomelane are also so charged with that mineral as to be quite black, though they are still hard and siliceous. The psilomelane also occurs in minute particles in the shale between the chert beds, making it black. The borders of the belt in which these layers of psilomelane occur are not sharply defined, but the mineral has been mined in open cuts from two to six feet wide. The ore appears to be essentially a primary deposit, contemporaneous with the deposition of the silica that formed the cherts, although doubtless some of the psilomelane has since migrated into adjoining beds."

The deposit has been located as mining claims by Arthur B. Riehl, 1166 Washington Street, and Louis H. Eilken, 1373 Seventh Avenue, San Francisco; the island being government land. Should the manganese prove unmarketable, the associated red shales and jasper have commercial possibilities as mineral paint, roofing granules or stucco 'dash.'

MINERAL WATER.

Mineral water has been a commercial product of Contra Costa County for many years. The mineralized springs, notably Byron Hot Springs, is among the most popular and well-known resorts in the state, being easily accessible from the Bay region by automobile.

Alhambra Springs. Owner, Alhambra Natural Water Company, L. M. Lassell, Martinez, California. Six more or less mineralized springs are in this group, situated in a narrow canyon six miles south of Martinez in Sec. 2, T. 1 N., R. 3 W. Four of these have been developed. Water from No. 1, the most highly mineralized spring, was formerly bottled for medicinal purposes, but it is no longer used. Springs No. 2, 3 and 4 are only slightly mineralized and the water from these is piped to the bottling works at Martinez where it is used in the manufacture of soft drinks and bottled for drinking. It is distributed in five-gallon bottles. Tank-car shipments are made to Oakland and San

¹ Lawson, A. C., U. S. Geological Survey, San Francisco, Folio No. 193, p. 23.

Francisco. The total flow of the springs is about 150,000 gallons per month.

Analysis of Water from Alhambra Springs.

(Analyst, Thomas Price and Son; authority, advertising matter.)

	Grains per United States gallon	
	No. 1 Spring	No. 2 Spring
Calcium chloride -----	157.24	-----
Magnesium chloride -----	24.25	-----
Potassium chloride -----	7.58	1.395
Sodium chloride -----	492.65	2.028
Calcium bicarbonate -----	-----	19.247
Magnesium bicarbonate -----	-----	14.680
Sodium sulphate -----	2.48	15.548
Sodium sulphide -----	8.39	-----
Ferrous carbonate -----	1.16	-----
Aluminum oxide -----	-----	0.238
Aluminum sulphate -----	2.13	-----
Silicon dioxide -----	1.22	0.758
Total residue -----	697.10	53.894

Bibl: State Mineralogist's Reports XIII, p. 508; XVII, p. 56;
U. S. Geol. Survey Water Supply Paper 338, pp. 293-294.

Byron Hot Springs. San Francisco office, 720 Phelan Building. These noted mineral springs are situated near the southeastern corner of Contra Costa County on the western edge of San Joaquin Valley in a saline flat, partly surrounded by low hills. They are one-half mile from the station of the same name on the Southern Pacific railroad, and are also easily reached by automobile over good highways. The distance from Oakland City Hall is 55 miles. The springs, eight of which have been improved, are described by Waring,¹ in part, as follows:

“A small warm sulphur spring supplies a drinking basin in the main grounds; warm sulphur mud and water baths and a sulphur plunge are about 250 yards southeast of the hotel grounds. A strongly sulphureted spring, 83° in temperature, forms a slightly used drinking pool at one side of Sulphur Plunge, and on the opposite side is a well from which mineral water is pumped to bathtubs in the hotel. In the summer of 1908 the water in this well stood about eight feet below the surface and its temperature was 112° to 115°. About 250 yards beyond the Sulphur Baths and Sulphur Plunge is an enclosed swimming pool, known as the Gas Plunge, in which the temperature is about 88°. Between the two bathing establishments are two cemented drinking springs, known as the Hot Salt and the Liver and Kidney springs. The Hot Salt Spring, with a temperature of 120° and a flow of about two gallons a minute rises in a small, domed, concrete house; the Liver and Kidney Spring rises in a concrete basin 25 yards southward. In 1908 its temperature was 73°, but its flow was not appreciable. Near the base of a low hill 250 yards to the southwest is a tile-lined basin or well, marked ‘Surprise,’ which contains strongly saline water about 70° in temperature.”

The resort is equipped with a commodious modern brick hotel and bungalows. Tennis courts, a golf course and other amusements are provided for guests. A medical staff gives advice in the medical use of the various waters and baths. The so-called mud baths are in reality

¹ Waring, Gerald A., U. S. Geol. Survey Water Supply Paper 338, Springs of California.

packs in a clean, flaky peat material rather than mud. The resort is open the year round.

Analyses of the water from Springs No. 1, 2 and 3, made by Curtis and Tompkins, in 1911, are shown below. Authority, advertising matter. Expressed in grains, per gallon.

No. 1 "Hot Salt" Spring		No. 2 "Liver and Kidney" Spring		No. 3 "White Sulphur" Spring	
The water has a temperature of 122 degrees F.		The water has a temperature of 58 degrees F.		The water has a temperature of 70 degrees F.	
	Grs. per Gallon		Grs. per Gallon		Grs. per Gallon
Ammonium chloride -----	1.78	Ammonium chloride -----	2.23	Ammonium chloride -----	0.02
Lithium chloride -----	4.20	Lithium chloride -----	0.72	Potassium bromide -----	0.16
Potassium bromide -----	1.55	Potassium bromide -----	1.59	Potassium iodide -----	0.16
Potassium iodide -----	1.24	Potassium iodide -----	1.26	Potassium chloride -----	0.37
Potassium chloride -----	2.13	Potassium chloride -----	3.18	Sodium chloride -----	17.92
Sodium chloride -----	572.00	Sodium chloride -----	639.52	Sodium metaborate -----	1.47
Sodium metaborate -----	4.29	Sodium metaborate -----	6.14	Sodium sulphide -----	0.88
Magnesium chloride -----	24.95	Magnesium chloride -----	29.57	Sodium sulphate -----	5.13
Calcium chloride -----	106.00	Calcium chloride -----	81.21	Sodium carbonate -----	1.38
Calcium sulphate -----	Trace	Calcium sulphate -----	Trace	Sodium bicarbonate -----	19.71
Calcium phosphate -----	Trace	Calcium phosphate -----	Trace	Calcium phosphate -----	0.10
Calcium bicarbonate -----	10.42	Calcium bicarbonate -----	18.85	Magnesium bicarbonate -----	3.07
Ferrous bicarbonate -----	0.47	Ferrous bicarbonate -----	0.60	Calcium bicarbonate -----	3.47
Barium bicarbonate -----	0.68	Barium bicarbonate -----	0.86	Ferrous bicarbonate -----	0.28
Strontium bicarbonate -----	0.12	Strontium bicarbonate -----	0.13	Barium bicarbonate -----	
Silica -----	1.74	Silica -----	1.80	Strontium bicarbonate -----	
				Silica -----	2.70
Total -----	731.57	Total -----	787.66	Total -----	56.82
GAS		GAS		GAS	
	c. c. per liter		c. c. per liter		c. c. per liter
Free carbon dioxide -----	4.45	Free carbon dioxide -----	7.23	Free carbon dioxide -----	None
Free hydrogen sulphide -----	0.41	Free hydrogen sulphide -----	0.28	Free hydrogen Sulphide -----	16.7

Ferndale Springs. Consists of two carbonated springs which issue from a thick sandstone stratum on the south side of Vaca canyon about six miles south of Martinez. The water from the principal spring was formerly marketed by the Richmond Soda Works, 1134 Ohio Street, Richmond, for drinking purposes, but it is not now being utilized.

Bibl: State Mineralogist's Report XVII, p. 60; U. S. Geol. Survey Water Supply Paper 338, p. 208.

*Pine Canyon Sulphur Spring.*¹ "A moderately sulphureted spring emerges about four miles in a direct line northward from Danville, in Pine Canyon, which is at the western base of Mount Diablo. The water forms a clear pool, about 15 inches wide and 4 feet long, in thick bedded sandstone at the southern side of the creek. The yield is larger than is usual for springs of this class, being estimated at five gallons a minute, and the temperature of the water (67°) is also somewhat above the normal. The spring has not been improved, but it has been visited by occasional picnic parties. There are seepages within five yards of the spring, and 1½ miles farther eastward, upstream, sulphureted water seeps from a bluff on the northern side of the creek. Only one spring of appreciable flow was observed along the canyon, however."

*Sulphur Spring Near Walnut Creek.*² "A group of sulphur springs lies near the northeastern base of a low ridge about two miles northeast of the town of Walnut Creek. The largest spring is on the ridge about 100 yards from its eastern base and 25 yards north of the county road. When the place was visited, the water rose in a board-curbed pool

¹ U. S. Geol. Survey Water Supply Paper 338, p. 270.

² U. S. Geol. Survey Water Supply Paper 338, p. 270.

protected by a latticed house and was piped to a cattle trough a few yards away. It yielded about three gallons a minute of mildly sulphureted water, 81° in temperature" * * *. "Five other smaller springs issue in a belt extending 350 yards along the base of the ridge, in and near the barnyard of Sulphur Springs farm. Two of them have been piped to water troughs near by. The other three are of seeping flow and form only small marshy places.

"The ridge is composed of sandstone the dip of which is nearly vertical, and strike S. 30° E. (magnetic) along the trend of the ridge. The steep inclination of the beds shows that intense movement has taken place here, and a fault . . . extends along the border of the valley land. This structural break probably accounts for the rise of the springs and also for their thermal character."

MOLDING SAND.

The growth of the iron and steel industry on the Pacific coast has created a demand for foundry sands, and deposits of sand suitable for brass, iron, and steel casting have been developed in various parts of the state to meet this demand. A large portion of that used at plants in Contra Costa County is obtained within the county.

Columbia Steel Corporation. For a number of years this company obtained sand for its molding department from a surface deposit situated about three miles west of Brentwood on the Marsh Creek road. This deposit has been abandoned and for the past three years it has used sand from a deposit on the property of the Southport Land and Commercial Company at Nortonville. The material mined is a cream-colored, soft, friable sandstone, immediately overlying and forming the roof of the Clark coal vein on the above property. This sandstone is very uniform and is said to run 96% silica. The bed averages about 70 feet in thickness, strikes east and dips north at an angle of 40°. A large entry has been run in westerly, from which open stopes or rooms have been mined out to the south following the bedding plane up. Pillars are left to support the roof, which stands well. Most of the mining is done during the summer season. The material is hauled to the Pittsburg plant by trucks.

PEAT.

The thickest deposits of peat in the state are believed to underlie the area following a line traced around the edges of the marshes and extending from Carquinez Straits to Stockton to Rio Vista and closing at the point of beginning. Peat beds within this area average six to 80 feet in depth. That portion of the county lying northeast of the Santa Fe railroad is largely peat land. Some peat has been dug and shipped from Werner and Orwood. It has not been utilized for fuel or industrial purposes in this state up to the present time.

PETROLEUM.

The possibilities of oil production in Contra Costa County are discussed by Vander Leck¹ in Bulletin 89, pp. 60-61. As this bulletin is

¹ Vander Leck, Lawrence, Petroleum Resources of California, Cal. State Mining Bur. Bull. 89, 1921.

out of print, his conclusions are included herein. He says, "The strata exposed constitute a nearly complete section of the Coast Range formations from the Franciscan to the Recent. Structurally, these beds have been sharply tilted, folded and faulted into a large number of more or less independent geological areas. This has resulted in preventing any one formation from being continuous over a large area, which is an unfavorable condition for the accumulation of petroleum.

"Those formations within the county which contain beds that might form oil, consist of an area of Chico shales on the north side of Mount Diablo; a small area of middle Eocene organic shales (Meganos) in the vicinity of Mount Diablo and finally an area of Monterey diatomaceous shale in the San Pablo and Rodeo valleys just east of the Berkeley Hills. However, none of these organic shale beds are continuous over a sufficiently large area to form any great amount of oil.

"Indications of petroleum are found along the north side of Mount Diablo, about seven miles due south of Antioch; and in the San Pablo Valley, east of the Berkeley Hills.

"The Mount Diablo indications consist of small intermittent seeps of light green oil, found in the vicinity of Oil Canyon, Long Valley and Deer Valley. Roughly, the territory embraced by the seepages and wells that have found small showings consist of Secs. 13, 14, 15 and 23, T. 1 N., R. 1 E. The formations exposed consist of beds of sandstone and shale of the Chico, dipping in a monocline of about 65° to the north. Beds of Eocene age overlie the Chico along the ridge north of Oil Canyon. Prospecting for oil in this district was first started in 1864, when several wells were drilled in either Sec. 13 or 14 to a depth of about 300 feet and encountered slight showings of green oil. In 1900 another attempt was made and several more wells were sunk to shallow depths and obtained small showings. The last well was drilled by the Atlas Development Company in 1918 on Oil Creek, in the SE $\frac{1}{4}$ of Sec. 15, T. 1 N., R. 1 E. A depth of 1823 feet was reached and as no showings of oil were encountered the well was abandoned. About 1500 feet up the canyon and due east along the strike of the formation from the Atlas well, is an old hole known as the Harding well. This was drilled to a depth of 978 feet and encountered green oil from 950 to 978 feet. It is now used as a water well and shows about one quart of green oil per day. There is no reason to believe that future drilling in this region would show any better results than the former attempts.

"Indications in the San Pablo Valley consist of seepages of heavy black asphaltic oil found in the vicinity of Lauterwasser Creek and in the lower end of the valley about two miles east of the town of San Pablo. A detailed geological map of this territory can be found in folio 193¹ and Arnold gives a brief description of the geology and development in Bulletin 304.²

"The structure in the vicinity of Lauterwasser Creek consists of a rather sharply folded anticline plunging to the southeast and truncated at the northwest end by a fault. The oil has collected in the sandy beds of the Orinda formation (Pliocene), having been formed in the underlying diatomaceous shale beds of the Monterey series, which at this point are about 300 feet thick.

¹ A. C. Lawson, United States Geological Survey folio 193.

² R. Arnold. Miner Ranch Oil Field. Bulletin 304. U. S. Geological Survey, 1907, Pages 339-342.

Beginning in 1889 and continuing up to 1900, eight wells were drilled on this structure, the depths ranging from 500 to 2700 feet; all encountered showings of oil and gas, but none showed sufficient quantities to be of commercial value. At the lower end of the San Pablo Valley about three miles east of the town of San Pablo, five wells were drilled to 1900 feet along a syncline in the Orinda formation. Slight showings of oil were encountered, but nothing of commercial value was developed. The oil has apparently collected in the sands of the Orinda formations from the Monterey diatomaceous shale, which outcrops to the east on Sobrante Ridge. Neither the geological conditions nor the results of wells drilled warrant any further attempts at development in this area."

Undiscouraged by past failures to obtain commercial production, a number of companies have started prospect wells in the county during the past few years and drilling is at present in progress.

From September, 1923, to December 31, 1926, the following notices of intention to drill were filed with the Department of Petroleum and Gas of the State Mining Bureau:

Year:	Company:	Location:			Well No.
		Sec.	T.	R.	
1923	Elsinore Oil Co. of Nevada -----	19	2	1	--
1924	Leachman and Marshall—Acolanes Ranch near Tunnel road -----		1	3	
1924	Wm. Edwards -----	31	2	2	1

Bibl: U. S. Geological Survey, San Francisco Folio 193; Bull. 340; State Mineralogist's Reports X, p. 165; XIII, p. 571; State Mining Bur. Bull. 19, pp. 156-157; Bull. 69, pp. 442-443; Bull. 89, pp. 60-61.

QUICKSILVER.

The *Ryne Quicksilver* mine, situated four miles southeast of Clayton, was a producer in 1875, 1876 and 1877, and at one time it is said to have produced as high as 85 flasks per month. The deposits are of very limited extent, however, and there has been no activity for years.

Bibl: State Mineralogist's Report VIII, p. 162; State Mining Bur. Bull. 27, p. 195; Bull. 78, p. 41; U. S. Geol. Survey Mon. XIII, p. 378.

STONE INDUSTRY.

(Crushed Rock, Sand, and Gravel.)

The production of the common structural materials in Contra Costa County, grouped under the heading 'Stone Industry,' has grown from a small beginning 30 years ago to a place second only to cement in value. The excellent transportation facilities afforded by water, rail, and highway and the proximity of the deposits and quarries to the metropolitan area around San Francisco Bay promise a steady growth to this important branch of the county's mineral industry.

CRUSHED ROCK.

Blake Bros. Co. (Blake Bros. Quarry); Anson S. Blake, president; H. Steinbech, secretary; home office, 204 Balboa Building, San Francisco; J. Asmussen, quarry superintendent. Blake Brothers operate



Quarry face before blasting, showing Coyote tunnel containing charge. Height of face at lowest point 220 feet. Blake Bros. Quarry, Contra Costa County.
Photo by courtesy of the company.



Same face after blasting. Charge 18,200 lbs. of 10% Judson and 20 lbs. of 40% for priming. Coyote tunnel 60 feet in length with drift to left 16 feet and drift to right 85 feet. 100,000 tons broken. Blake Bros. Quarry, Contra Costa County. Photo by courtesy of the company.

but a single quarry, which is located at the foot of Standard Avenue, Point Richmond, near the Richmond-San Rafael Ferry landing. This quarry is in the same range of hills as the Richmond Quarry of Hutchinson Co., Inc., and the old abandoned Point Molate quarry. The rock formation at Blake Brothers' quarry is very regular, consisting of hard blocky gray siliceous sandstone or trap rock. It has been opened up by a very large circular open cut with high face. A steam shovel is used to load the broken rock into 3½-yard bottom dump cars of special design, which are hauled to the crushing plant by steam locomotives. The plant has been in operation since 1907, and is built in two parallel units so that each may be operated independently. Electric power is used throughout with separate motors for all drives. Increased demand for special sizes of crushed rock has been met by the installation of new crushing, sizing and bunker equipment, including rolls for fine crushing, an innovation in plants of this character. Most of the output was formerly shipped by barge but since the completion of the Richmond Belt Line Railroad to the plant, shipments by rail and water are about equal. There is bunker storage for 24,000 tons. The plant is rated at 150 tons per hour capacity, and fifty men are employed.

Bibl: State Mineralogist's Report XVII, pp. 63-64.

Brooks Island Quarry. Healy-Tibbetts Construction Co., 64 Pine Street, San Francisco, operates a large quarry on Brooks Island, off Potrero Point, Contra Costa County. The quarry is operated primarily to take care of the company's contracts, but rock is also sold to other consumers. The quarry is equipped with a crushing and sizing plant of about 1000 tons daily capacity, but only riprap is being produced at present. The rock has been used recently for fills at the Carquinez bridge; on the Hetch Hetchy project at Dumbarton and at Pier 45, San Francisco. The material quarried for riprap is a buff-colored stone. A blue metamorphic sandstone of better quality is mined when crushed rock is produced.

Central Construction Co. (formerly Bates and Borland). J. E. Bowersmith, president; P. R. John, vice president; S. M. Chalmers, secretary; home office, 528 Oakland Bank Building, Oakland. This company has three quarries, their Stege Quarry in Contra Costa County and two in Alameda County.

Stege Quarry: This quarry has been worked for over twenty-five years. It was closed down in 1918, but reopened in 1922. It is situated near the top of the Berkeley Hills ridge opposite Stege (El Cerrito) at an elevation of close to 1000 feet. The crushing plant and bunkers are at the base of the ridge and are easily visible from San Pablo Avenue. Quarry and plant are connected by a gravity tram 4960 feet in length. The rock at the quarry is a hard blue metamorphic sandstone, but is not uniform throughout the deposit, and selective quarrying is necessary to obtain the best rock. It is mined by tunnels and glory-holes, using air drills and jackhammers. A Fordson tractor with flanged wheels hauls the loaded cars to the bunker at the head of the tramway. The tram has three rails above and two below the half-way passing point and two 5½-yard cars are used, the loaded car pulling up the empty. Speed is controlled by brake bands at the top. The wood brake shoes formerly wore rapidly, but by lubricating with water

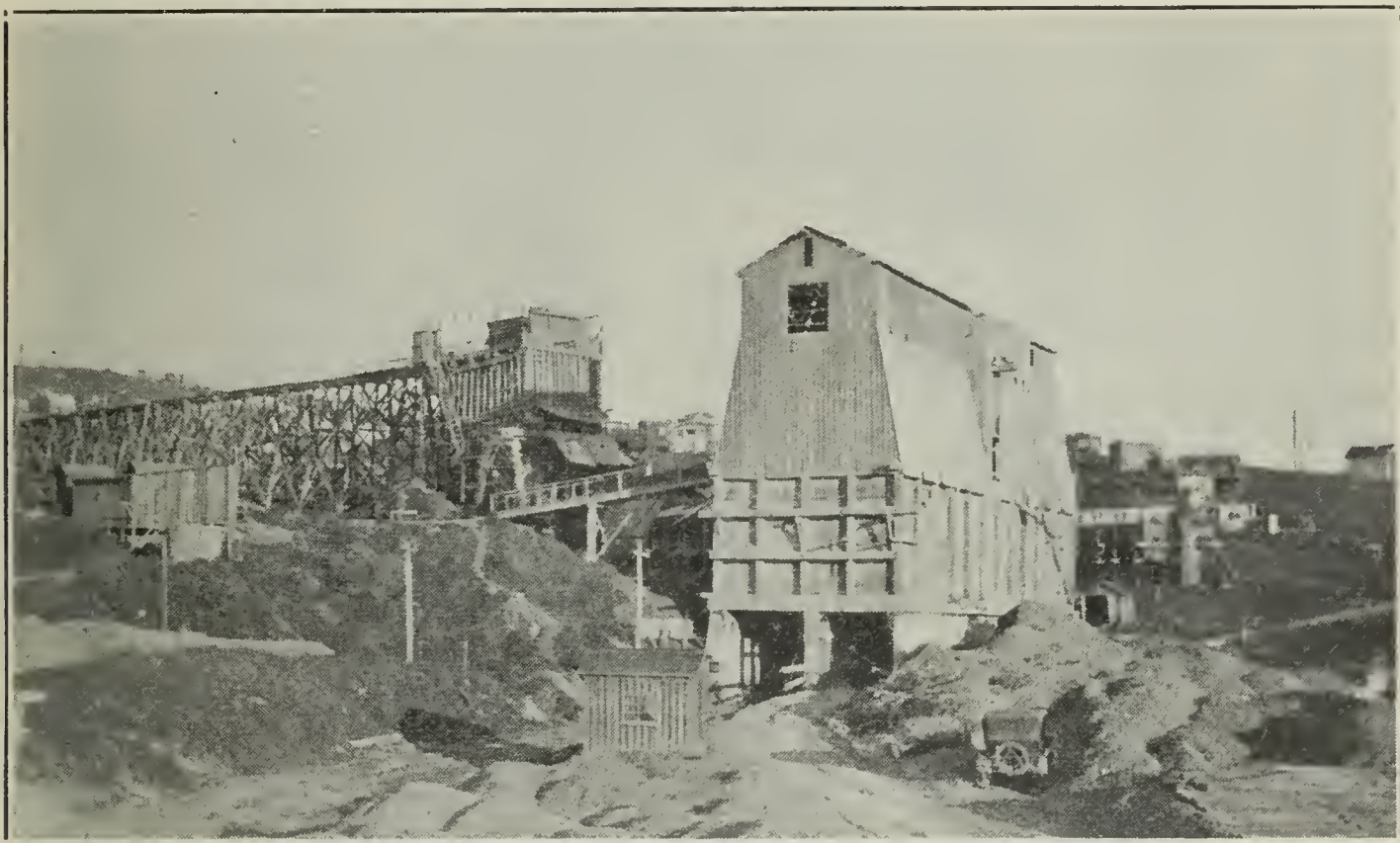


El Cerrito Quarry of Hutchinson Co., Inc., Contra Costa County. Photo by courtesy of the company.

mixed with a small amount of kerosene, their life has been increased to months instead of days. At the foot of the tram, the cars dump to a bin, which feeds a No. 5 gyratory. The discharge is elevated by a bucket elevator to a revolving screen 20' x 40" in five sections. Oversize goes to two No. 3 gyratory crushers and then to a second revolving screen 20' x 40", in five sections. The following sizes are produced: $2\frac{1}{2}$ "- $1\frac{1}{2}$ "; $1\frac{1}{2}$ "-1"; 1"- $\frac{3}{4}$ "; $\frac{3}{4}$ "- $\frac{1}{4}$ "; birdseye; $\frac{1}{4}$ "-dust; dust and waste.

The bunkers have a capacity of 2000 yards. A spur of the Santa Fe runs to the plant and cars or trucks may be loaded direct. There is also yard storage. Electric power is used, about 200 horsepower being required. The plant has a capacity of 350 yards per eight-hour day. An average of twenty-two men are employed at the quarry and crusher. G. McColl, superintendent.

Bibl: State Mineralogist's Report XVII, p. 61.

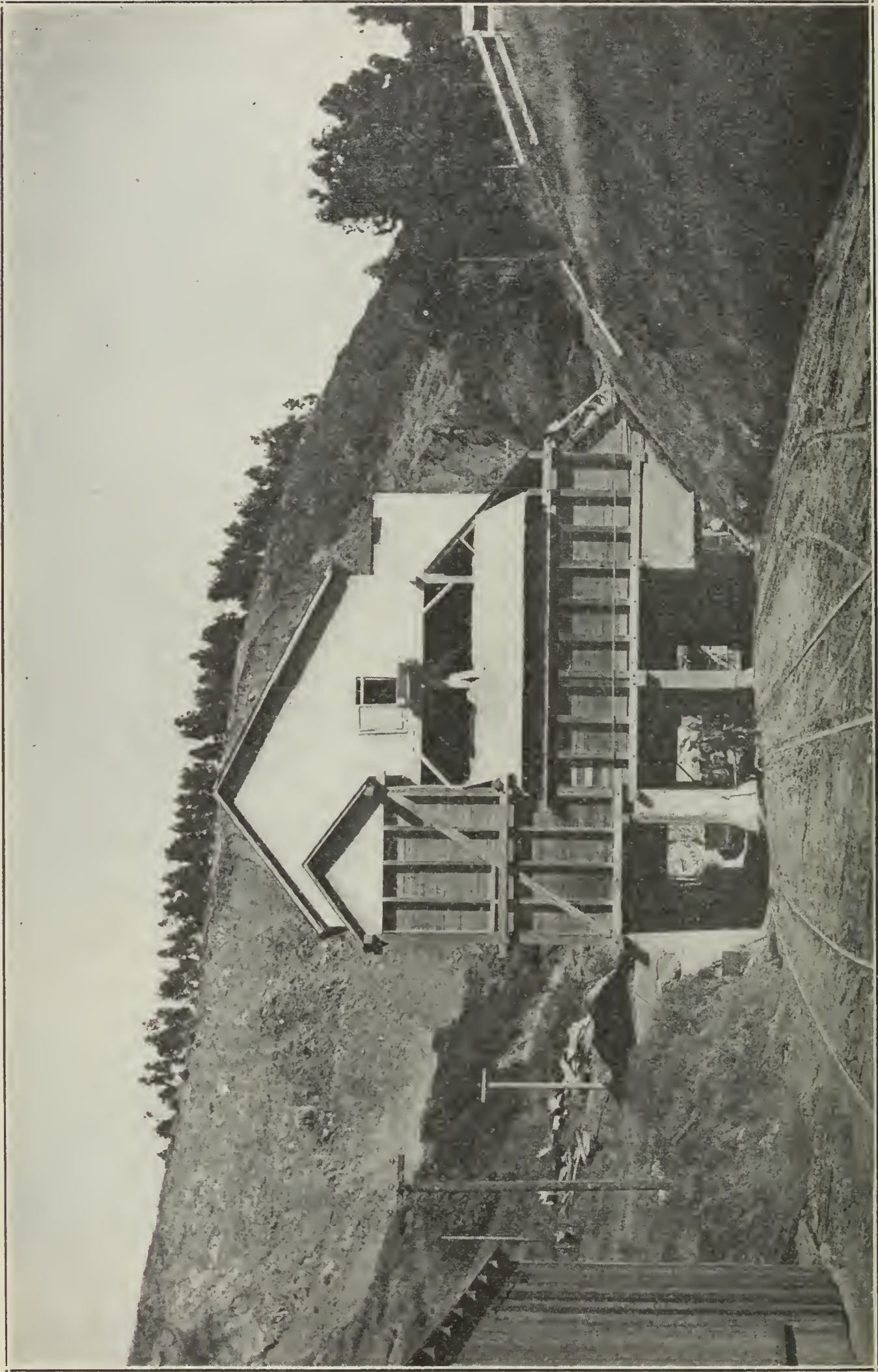


Foot of tramway, crushing plant and bunkers, Central Construction Co.'s Quarry, Contra Costa County.

Christen Quarry. Owner, J. M. Christen, Pacheco. This is a small quarry in buff-colored sandstone, situated about one-quarter mile west of Pacheco. The rock has been used occasionally for macadamizing the roads in that district. Idle at the time of visit.

Hutchinson Company, Inc. Dwight Hutchinson, president; Hardy C. Hutchinson, secretary; home office, 1706 Broadway, Oakland; W. C. Collins, superintendent of quarries. This company operates four quarries and crushed rock plants, of which two are in Contra Costa County, one in Marin, and one in Santa Clara. The two in Contra Costa County are known as the El Cerrito (formerly Stege Quarry) and Richmond Quarry.

El Cerrito Quarry: This quarry is located at the base of the Berkeley Hills opposite El Cerrito and adjacent to the large sub-station of the Great Western Power Company, visible from San Pablo Avenue. The ridge here has an abrupt slope and the quarry face is high. The



El Cerrito Quarry of Hutchinson Co., Inc., showing crushing plant and bunkers. Quarry in background—Contra Costa County.
Photo by courtesy of the company.

rock, which is usually classified as a hard blue metamorphic sandstone or 'trap' rock, is mined by two tunnels and glory holes. A Fordson tractor, running on rails, is used to handle the cars. These are dumped in a hopper discharging to an inclined belt-conveyor, which delivers the rock to bins feeding the crushers; or in wet weather the ore is dumped directly into the crushers which are set in pits. The primary crushing unit consists of two No. 5 gyratories. The discharge is elevated by bucket elevator, passes to two parallel 18' x 60" trommel screens. The oversize from the trommels goes to three No. 3 secondary gyratories. The discharge is again elevated and delivered to two sets of screens, a 10' x 48" trommel and a four-deck 3' x 5' Link-Belt Vibrator screen. The sizes segregated include: Rock dust, birdseye ($\frac{1}{8}$ " - $\frac{1}{4}$ "), $\frac{1}{4}$ " - $\frac{3}{4}$ ", $\frac{3}{4}$ " - $1\frac{1}{2}$ ", $1\frac{1}{2}$ " - 2" or $2\frac{1}{2}$ ". The crushing plant and bunkers occupy the narrow gap leading into the open quarry and the tail tracks for the railroad cars run back on the quarry floor. Yard stock is handled by an oil-burning steam crane and oil-burning steam shovel. Electric power furnished by the Great Western Power Company is used. A total of 320 horsepower is required. A spur of the Santa Fe provides an outlet for rail shipments. Trucks may also be loaded from the crusher bin or yard bunkers. The plant has a capacity of 1000 yards a day. A total of thirty-six to forty men are employed.

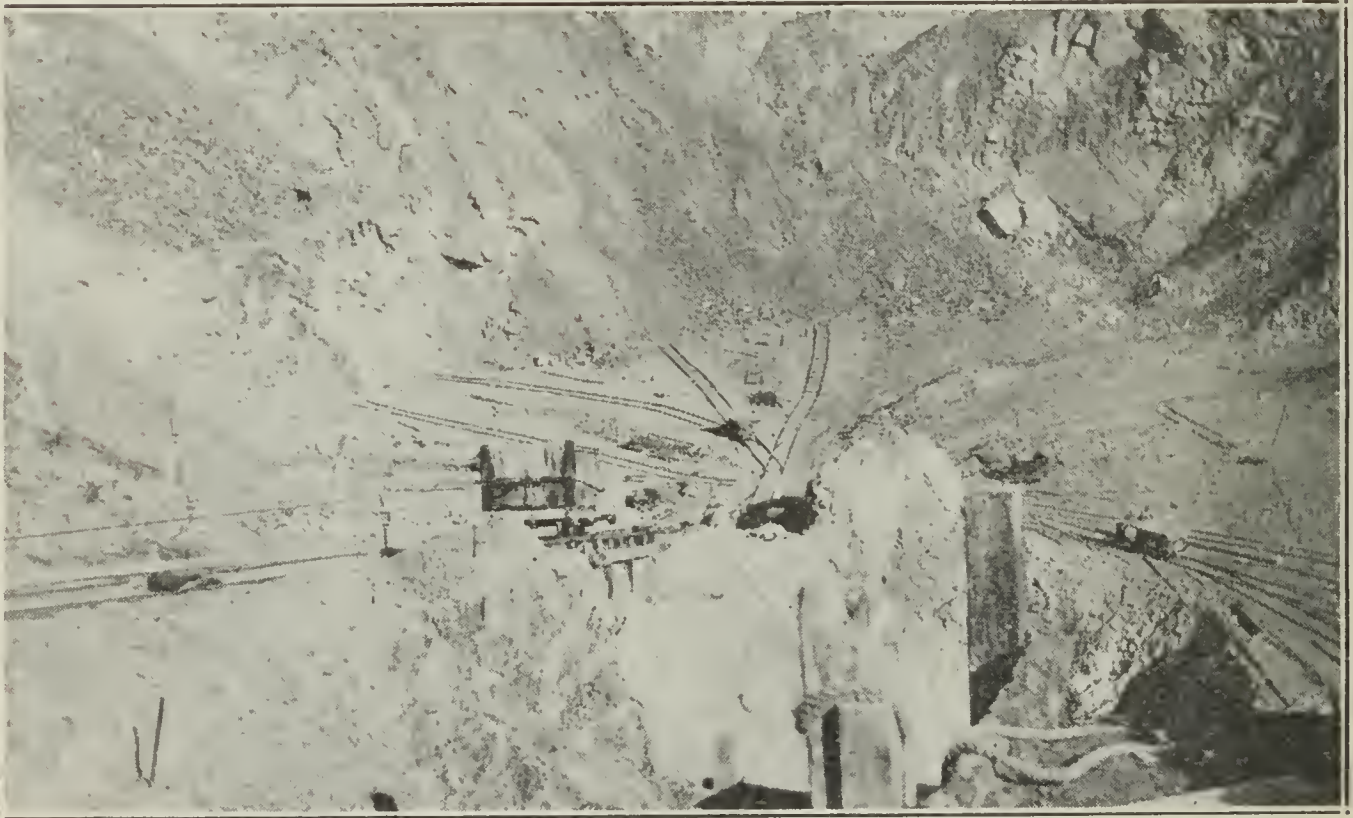
Richmond Quarry. This quarry of Hutchinson Company, Inc., is located at the water's edge about half way between Richmond Point and Potrero Point. The quarry is unique in that the floor is at present forty feet below sea level with only a narrow rim of rock preventing entrance of the bay water. The material being quarried is a hard fine-grained blue metamorphic intrusive rock and is of excellent quality. A new incline is being sunk 35 feet deeper, which will eventually lower the quarry floor to about 75 feet below sea level. The pit is circular in outline. Toe holes twenty feet deep are put in and after blasting the rock from three sides of the quarry it is hand-trammed to a center dump sunk below the floor and timbered over. A two and one-half-ton skip receives its load here and is hoisted up an incline and automatically dumped into the crusher bins on the rim. The initial breaker is a No. 4 McCully gyratory. The discharge goes to a revolving screen and oversize from the screen to a No. 3 gyratory in closed circuit. The undersize goes to another sizing trommel. Oversize is returned to the No. 3 gyratory and $\frac{1}{4}$ ", $\frac{3}{4}$ ", and $1\frac{1}{4}$ " sizes are usually segregated. Other sizes may be produced if desired. A belt conveyor draws from the bunkers and loads direct to barges. A small amount is also handled by trucks and there is a spur of the Santa Fe within 100 yards. A small amount of sandy loam overburden and dust is washed out to waste by a Byron and Jackson 3"-centrifugal pump. Electric power from the P. G. & E. Company's lines is used, about 200 horsepower being required. The plant has a capacity of 300 yards per day. Forty men are employed.

Bibl: State Mineralogist's Report XVII, pp. 63, 65. The Explosive Engineer, Vol. 4, No. 8, August, 1926.

Slater Quarry. This quarry is a small one, situated on the same ridge as the Christen Quarry, about one-half mile south of Pacheco. It is worked intermittently for road use, but was idle at the time of



Richmond Quarry of Hutchinson Co., Inc. The quarry is to the left of crushing plant and bunkers, Contra Costa County.



Richmond Quarry of Hutchinson Co., Inc. Floor of quarry 40 feet below sea level. Loaded car is shown on incline between loading station in pit and crusher on top.

visit. There is a small outcrop of limestone exposed above the sandstone in the quarry.

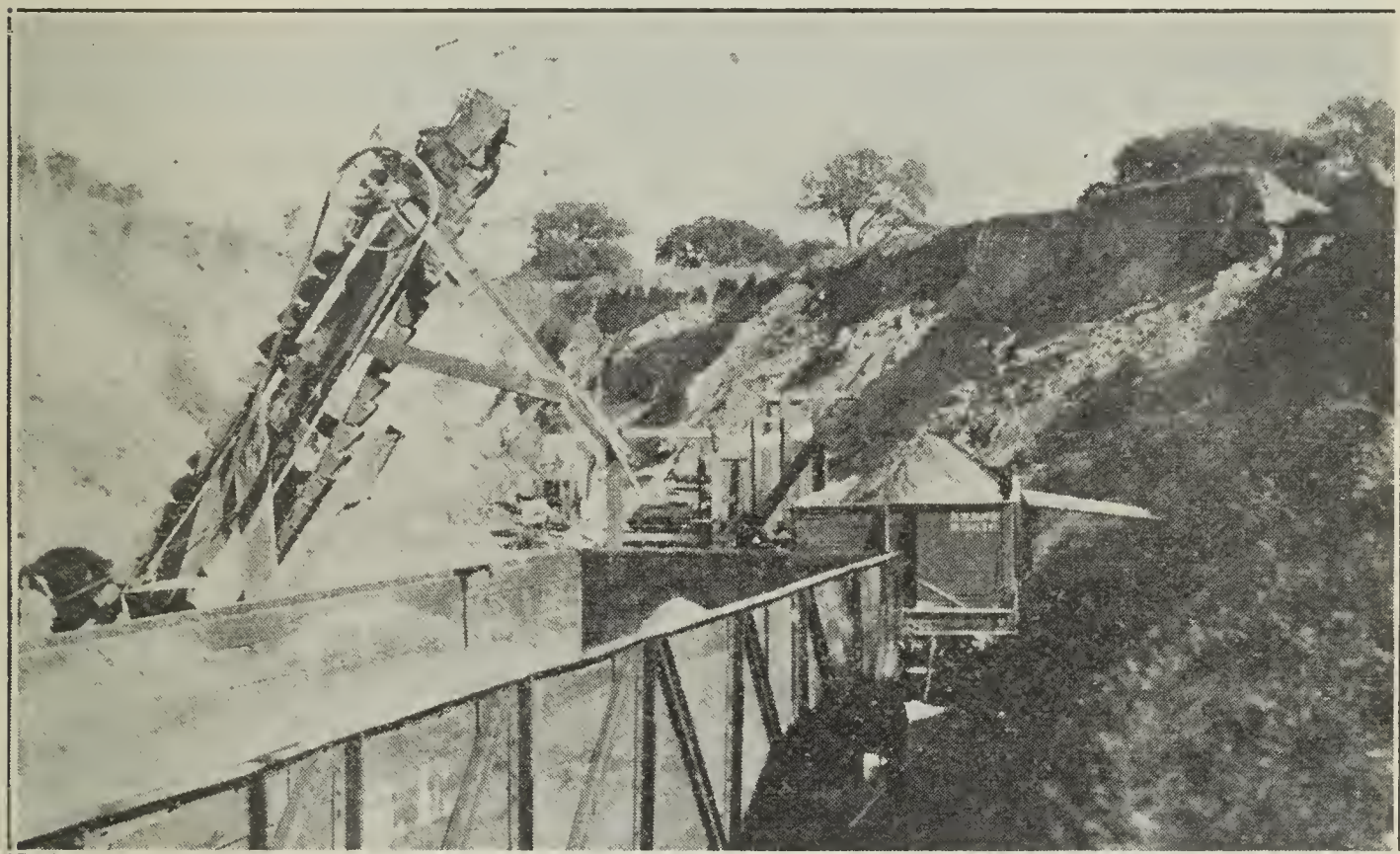
Bibl: State Mineralogist's Report XVII, p. 64.

GRAVEL.

There are no gravel screening or crushing plants operating in the county.

SAND.

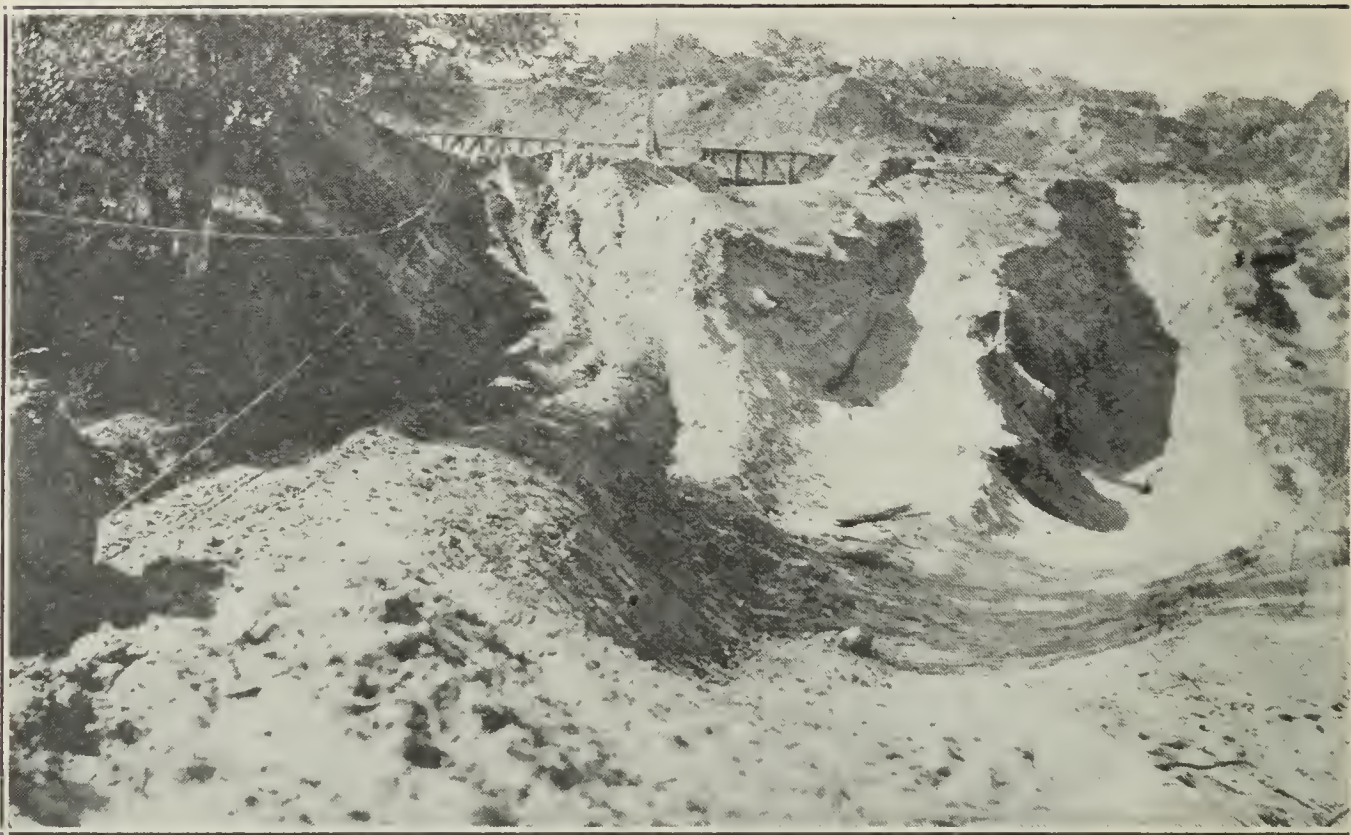
Dunes of fine sand border the south shore of the San Joaquin River between Antioch and Marsh Landing, a distance of about two miles. The Santa Fe tracks parallel the dunes most of the way. Early attempts to manufacture sand-lime brick were made here. These enterprises did not prove successful, although some of the brick are still in evidence and are said to be of good quality.



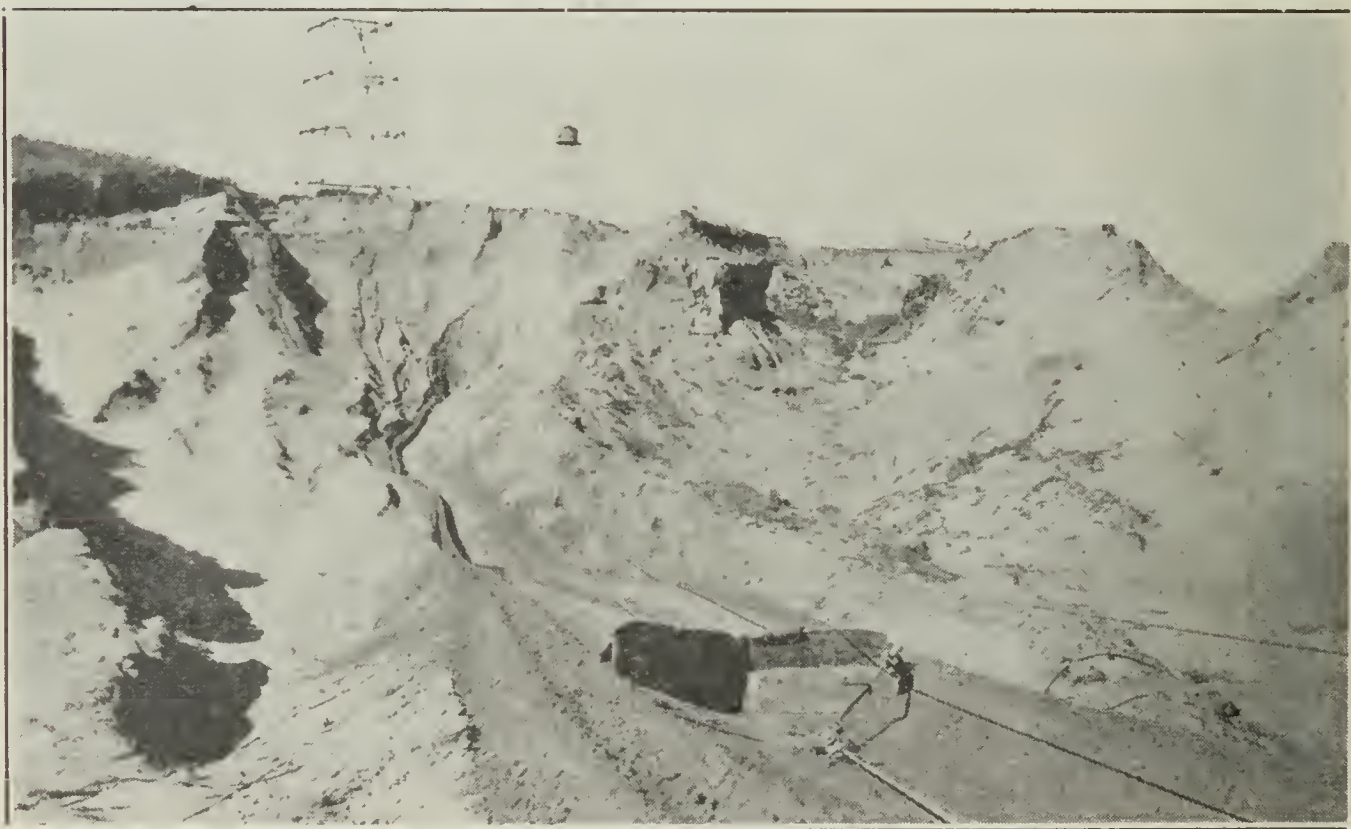
Sandpit of Antioch Sand Co., Contra Costa County.

Antioch Sand Company, Antioch; A. D. McCaddom, owner. This sand pit is situated about one mile east of Antioch. The deposit consists of clean fine dune sand. The face of the bank at present is about 50' in height, but it has a depth of 120' farther in. In parts of the deposit near the surface the sand is free flowing, but most of it has a tendency to pack and will not flow from a bunker, the angle of repose being practically vertical. The portion being mined is at present about 40' in depth. Below this is a layer of 3' of very fine tight sand, referred to as 'hard pan.' Underlying the above is a 3' stratum of coarse sand, the bottom of which is 12 feet above high water level of the river. Very moist fine sand underlies the 3' layer of coarse sand. The bottom of the pit is kept just above the 'hard pan' stratum.

The sand is delivered to a loading bunker by drag-line scraper. A bucket-elevator loader draws from the bunker and delivers to railroad cars. A small dryer has been installed at the plant and a portion of



Morris Sand Pit, Contra Costa County.



E. B. and A. L. Stone Co.'s sand pit, Contra Costa County.

the sand is dried and run over a Rotex screen producing a very fine product, 'sand dust,' which is sacked. Both the bank run product and the sand dust are used exclusively in asphaltic work. Electric power is used, about 80 horse power being required. Two to four men are employed, according to the season.

Morris Sand Pit. Benj. Morris, Box 845, Antioch, is producing sand from his pit a little farther east along the dune. He operates his own and also pits on the properties of R. B. Mitchell, 830 Powell Street, San Francisco, and Louise Schellet, of Antioch. The sand is elevated by an electric drag-line scraper and delivered direct to railroad cars on a spur of the Santa Fe, which runs to the pit.

E. B. and A. L. Stone Company; address, Claus Spreckels Building, San Francisco. This company operates a sand pit adjacent to that of the Antioch Sand Company. A 75-h.p. drag-line hoist is mounted on a platform over a spur track of the Santa Fe Railroad in the pit. The material is dumped direct to the cars. The bank here is about 70 feet high at present and the drag is 600 feet. Electric power is used. Only one man is required for operating.

Robert Easley and Jacob Bonslette, of Antioch, have erected a loading platform and hoist house and are preparing to produce from the dunes at a point just outside the eastern limits of Antioch.

Other idle deposits are owned by Arthur Frank, Box 185, Antioch; Nina Nason, Antioch; W. E. Buck, No. 2 Pine Street, San Francisco; Nat Cleaves, Antioch; and Lina M. Owens, 2524 Benvenue Avenue, Berkeley. The latter two properties are used as a park and beach.

LOS ANGELES FIELD DIVISION.

W. BURLING TUCKER, Mining Engineer.

MINERAL RESOURCES OF SANTA CATALINA ISLAND.

Santa Catalina Island is located south of San Pedro, and 18 miles beyond the mainland, and is under the jurisdiction of Los Angeles County. The island is approximately 25 miles in length and 7 miles in breadth, with an area of about 48,000 acres, its general physical characteristic being mountainous. The island may be considered as two islands joined together by a narrow neck of land. The largest of the two divisions contains about three-quarters of the whole area, and is traversed by a mountain ridge extending from the south in a northeasterly direction until nearing the east coast, when it turns west but does not cross the isthmus. Along the ridge that has a westerly trend are the principal peaks or highest parts of the island known as Ruby Hill, Black Jack Mountain and Razor Back Mountain. The highest point is Black Jack Peak, which has an elevation of 2000 feet, while the average altitude of the main backbone is from 1400 to 1600 feet.

The principal harbor is located at Avalon, where the famous summer and winter resort of the island is located. Avalon is situated on the southeast coast of the island, at the head of a small bay. The mouth of the bay is about one-half mile across, flanked on both sides by bluffs rising 300 feet out of the water. The distance around the bay is a little over one mile.

General Geology.

The main portion of the island consists of Franciscan formation while the other portion is made up of lavas and tuffs, chiefly andesite. In the vicinity of Black Jack and Ruby peaks, the formation consists largely of garnetiferous hornblende, although the immediate peaks are composed of volcanic tuff and lava. Northeast of Black Jack Mountain is a belt of micaceous schist. On the east coast of the island in the neighborhood of Potts' Valley, the bluffs are made up of trachyte. To the south of Potts' Valley, a quartzite dike runs down to the ocean separating the garnetiferous hornblende on the south from the metamorphic slates on the north. The veins that occur in the metamorphic schist trend north and south and have vertical dips. South of Avalon, in what is known as Renton Canyon, which has a southerly course from Pebble Beach, there are a series of parallel veins that occur in the earlier phase of andesite. These veins strike east and west, the most southerly known as the Renton vein system dips 60 to 70° north. The Quarry Vein dips 70° south. The ore consists of galena, sphalerite, and pyrite. The vein material of the Renton Vein series is made up of orthoclase, oligoclase, quartz, calcite, barite and muscovite. The material of the Black Jack Vein is made up of garnetiferous hornblende, quartz, calcite, barite and muscovite. The veins vary in width from 4 to 15 feet.

History.

Catalina Island was first discovered in 1542 by Captain Juan Rodriguez Cabrillo, a Portuguese navigator sailing under the flag of Spain. Later, in 1602, Sebastian Viscaïno, a Spanish navigator visited

the island, and christened it 'Santa Catalina Island.' Later, the island became the property of Mexico and was granted by Mexico to Pio Pico, Governor of California, Governor Pico later deeded the island to Nicholas Covarrubias. In 1863 it was purchased by James Lick, of San Francisco, and that year the first mineral was discovered on the island, considerable prospecting was done along the different veins, and the miners formed the San Pedro Mining District. The first claims were located in April, 1863, by Martin M. Kimberley and Daniel E. Way. The mining boom collapsed in 1864, due to an order of the United States Government for the miners prospecting on the island to leave. The island was purchased in 1887 by George R. Shatto. An English mining syndicate later took an option on the property, and during the tenure of their lease this company did considerable development, and it is reported, silver ore was shipped to smelters on the mainland. The English mining syndicate suspended operations in 1892 and the island was sold by Mr. Shatto to the Banning Bros. who turned it into a pleasure resort. In February, 1919, Santa Catalina Island was purchased by William Wrigley, Jr., of Chicago, Illinois. Mr. Wrigley expended a considerable amount of capital in developing Catalina Island, as a 'World Renowned Pleasure Resort.' Late in 1923, Mr. Wrigley started prospecting and exploration work on the different mineral showings on the island, and development work on the old Black Jack Mine located on Black Jack Mountain. The exploration of this property was encouraging and considerable ore has been developed.

During 1924, 250 tons of ore were shipped from this mine to the Selby smelter, San Francisco. It is reported the ore averaged \$50 per ton in lead and silver. In December, 1925, the company completed a 100-ton flotation plant for the treatment of the ore from the Black Jack Mine. The plant is located at White's Landing, 4 miles north of Avalon. In the early part of 1926, development work was started on the Renton Vein, which was discovered in the building of an auto road to this section of the island, and several other veins have recently been exposed that are parallel to this vein. The quarry vein was exposed in the rock quarry during the excavation of rock material, and development work on the vein has exposed a considerable tonnage of ore. Water for the island is supplied from wells and from a large dam located at Middle Ranch from which the water is brought by a 12-mile pipe line over the mountains to Avalon, insuring an adequate supply of water for all purposes. The mines are operated by the Santa Catalina Island Company, William Wrigley, Jr., president; D. M. Renton, vice president and general manager; David P. Fleming, secretary; and E. H. Pattison, engineer in charge of mining operations.

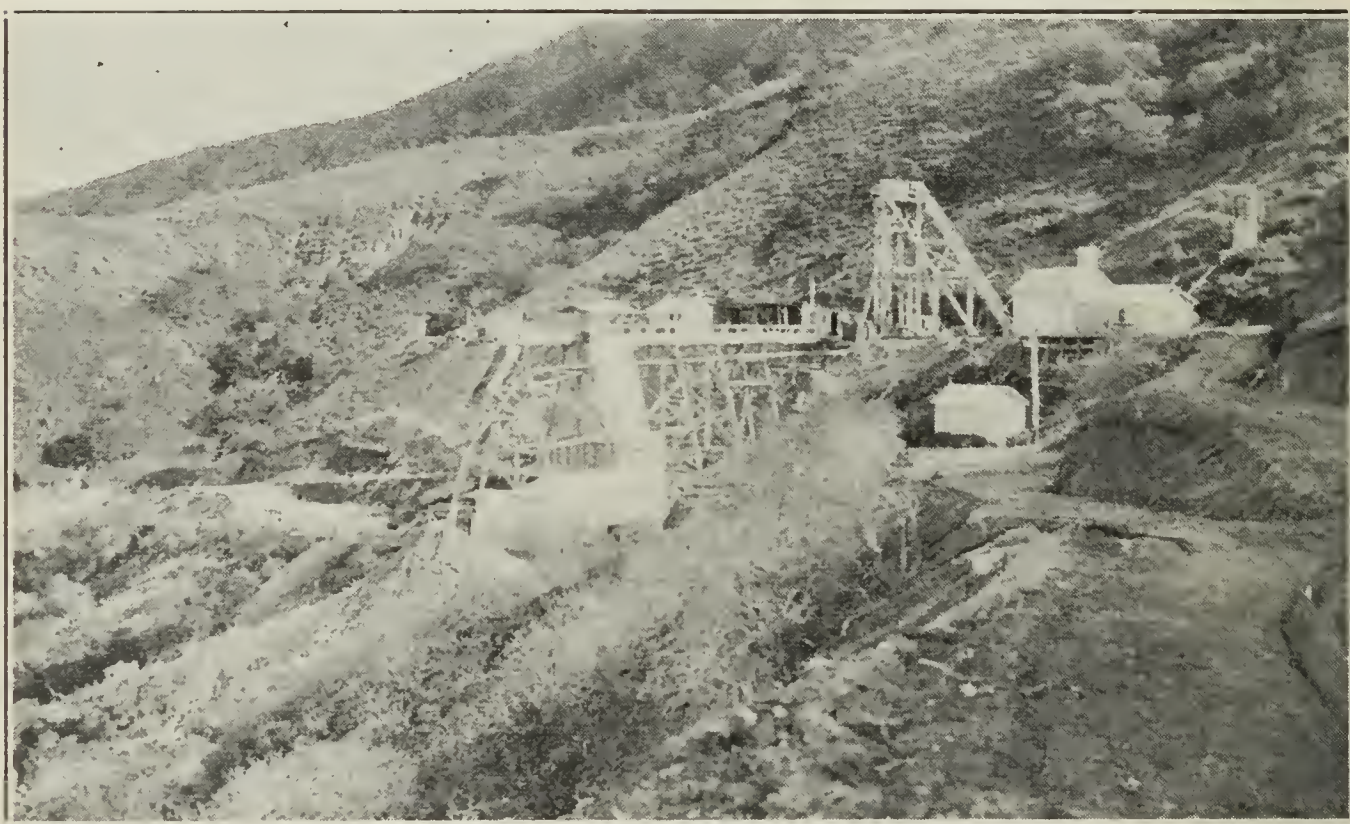
Mines.

Black Jack Mine. It is located on the northeast slope of Black Jack Mountain, 2 miles west of White's Landing, and 14 miles by road northwest of Avalon. Elevation 1540 feet.

The vein occurs in a belt of hornblende schist that strikes northwest and dips 70° east. The hornblende schist is exposed east of Black Jack Peak but is covered by a flow of andesite to the west. The vein trends N. 30° W., and dips 60° E. The width of the vein varies from 4 to 12 feet. The vein is mineralized with sphalerite, galena and pyrite. The

gangue minerals are hornblende, quartz, barite, calcite and muscovite. The ore-shoot developed from the 400-foot level to the surface was 40 feet in length, and from 6 to 12 feet in width. This orebody carried higher values in lead, zinc and silver than the ore now being worked on the 500-foot level. From upper workings considerable high grade lead-zinc ore was mined and sorted for shipment. The ore developed on the 500-foot level is 100 feet in length, and has an average width of 25 feet. There is a possibility that this shoot of ore is of greater length as the face of the stope shows ore for the full width of 25 feet. The ore carries 6% zinc, $1\frac{1}{2}\%$ lead, and from 2 to 3 ozs. in silver.

Development consists of a 3-compartment vertical shaft 525 feet deep, with levels driven on the vein at 400 and 500 feet. North of this shaft the ore was worked from No. 1 tunnel driven on the vein, through a winze to the 400-foot level with levels at 100, 200, 300, and 400 feet. A drift on the 500-foot level is 390 feet in length, of which 100 feet is in



Head frame and ore bins. Black Jack Mine, Santa Catalina Island.

ore. The total amount of drifts and crosscuts amount to 4400 feet. The present daily production is about 40 tons of ore. Ore from the main shaft is trammed to ore bins having a capacity of 225 tons. The ore from bins is transported by aerial tram, a distance of 2 miles to storage bins at the mill located at White's Landing. The ore buckets have a capacity of 800 pounds each.

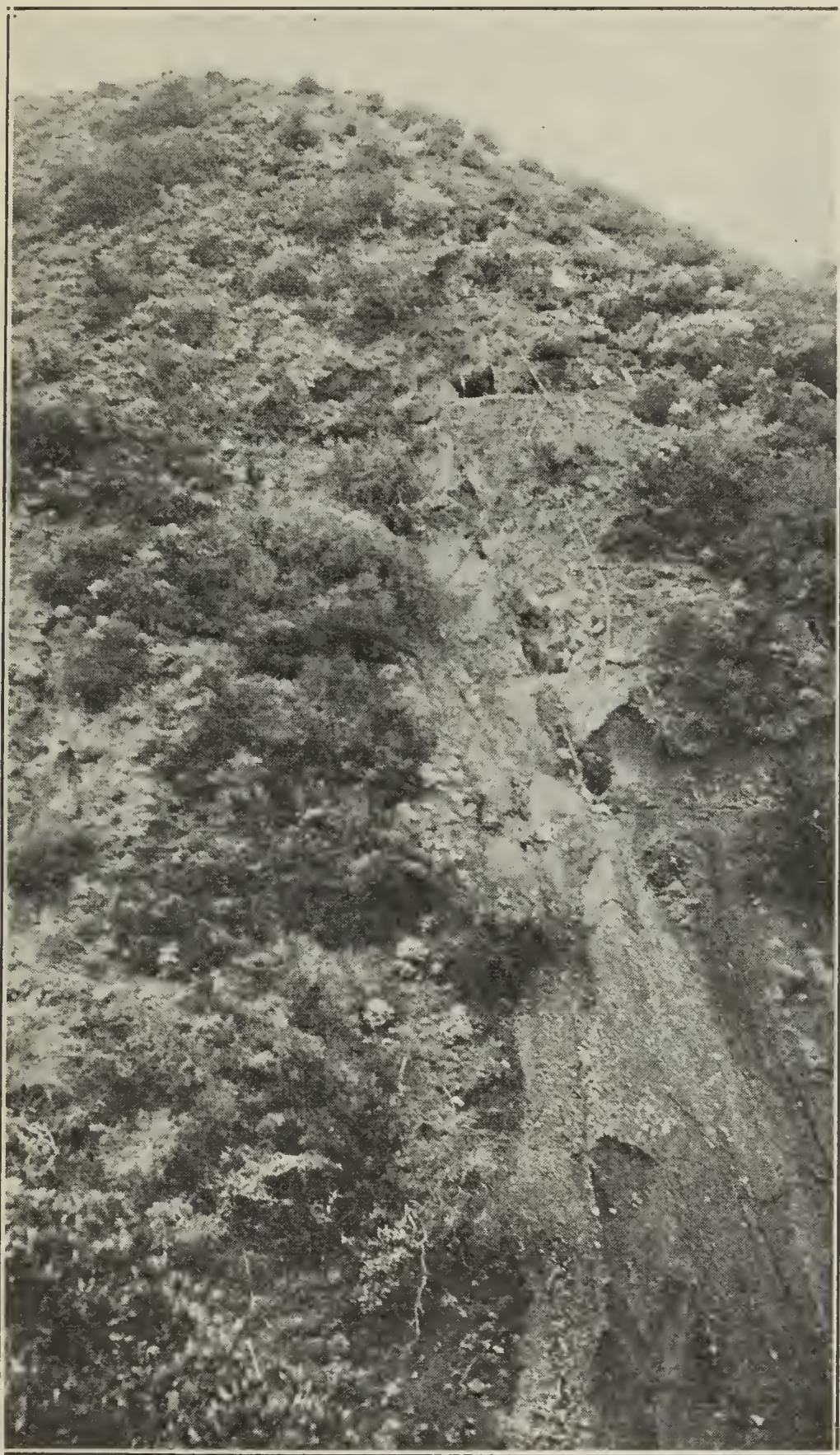
Equipment consists of 75-h.p. double drum electric hoist, Imperial Type X R. M.; Ingersoll-Rand compressor driven by 100-h.p. motor; blacksmith shop. Twenty-five men are employed.

Renton Vein Mine. It is located 2 miles southeast of Avalon, in Renton Canyon, which runs in a southerly direction from Pebble Beach. Elevation 700 to 1100 feet.

In this area five parallel veins occur in andesite. These veins strike east and west, and dip 60° north. The veins have widths varying from 4 to 6 feet. The main Renton Vein, in one place attained a width of

18 feet. The ore below No. 3 tunnel level is sphalerite and galena with silver values. It carries 8 to 12% zinc, $1\frac{1}{2}$ to 2% lead, and 2 to 3 ozs. in silver.

Development consists of 4 tunnels on the main Renton Vein. At an elevation of 1085 feet, No. 1 tunnel is driven west 200 feet. At an eleva-



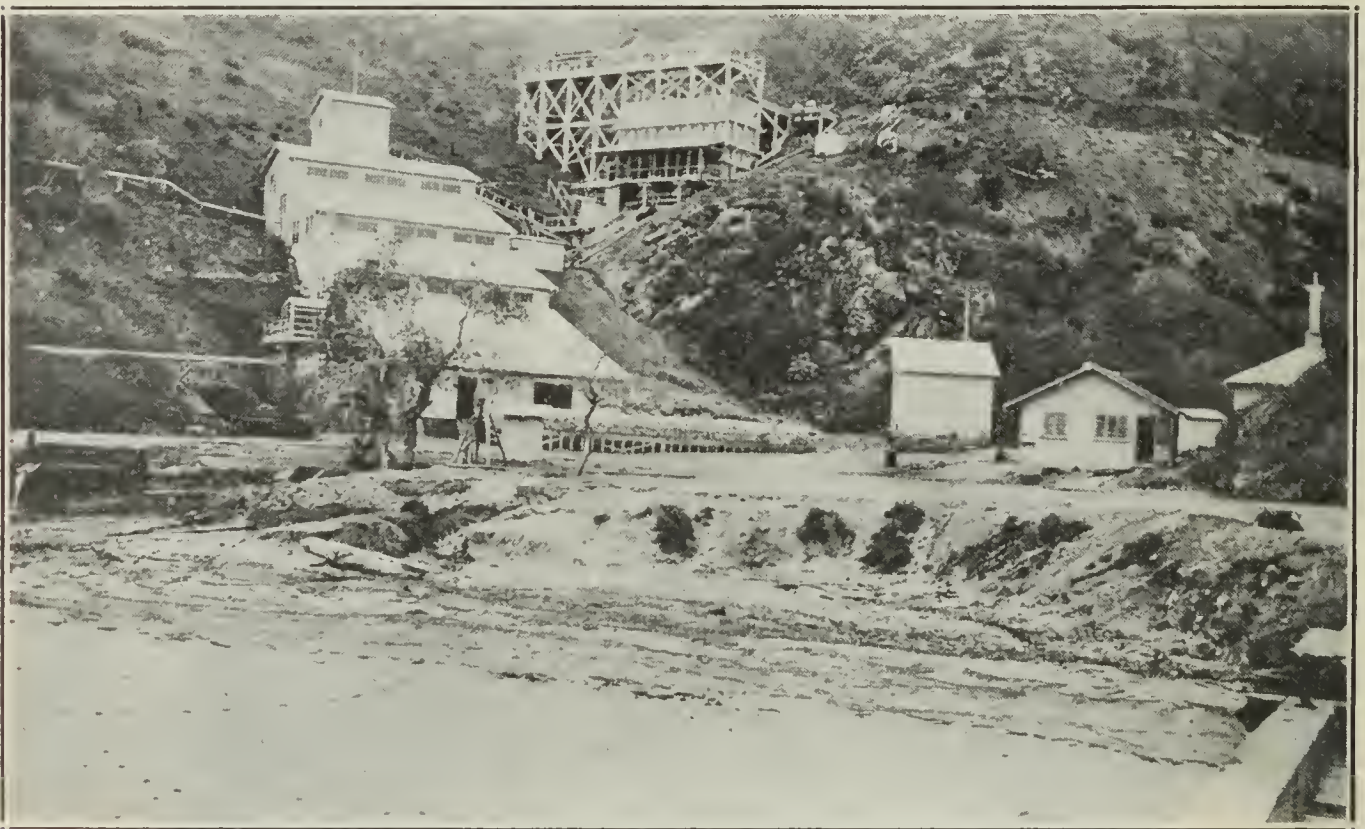
Outcrop of Renton Vein showing No. 1 and No. 2 tunnels,
Santa Catalina Island.

tion of 985 feet, No. 2 tunnel is driven west 225 feet. At an elevation of 879 feet, No. 3 tunnel is driven northwest 645 feet to the vein, and west on the vein 130 feet. At an elevation of 716 feet, No. 4 tunnel is driven south as a crosscut 400 feet to the vein, with a drift on the vein of 150 feet, developing a shoot of ore 130 feet in length with an

average width of 6 feet. At an elevation of 514 feet, No. 5 tunnel is driven west on a parallel vein, known as Wrigley Vein. Total drifting on this level is 630 feet, and two parallel veins have been developed that trend east and are 100 feet apart. The ore mined through tunnel No. 4 is trammed to ore bins having a capacity of 100 tons. From these bins it is transported over a jig-back tram, having a length of 700 feet, to an ore bin from which it is fed to a sorting belt, where waste is sorted out, the ore going to 100-ton storage bin. The ore from this latter bin is transported over aerial tram 3000 feet in length to a storage bin at Pebble Beach, which has a capacity of 225 tons.

Quarry Mine. It is located west of the Rock Quarry, $1\frac{1}{4}$ miles south-east of Avalon, and southwest of Pebble Beach. Elevation 300 feet.

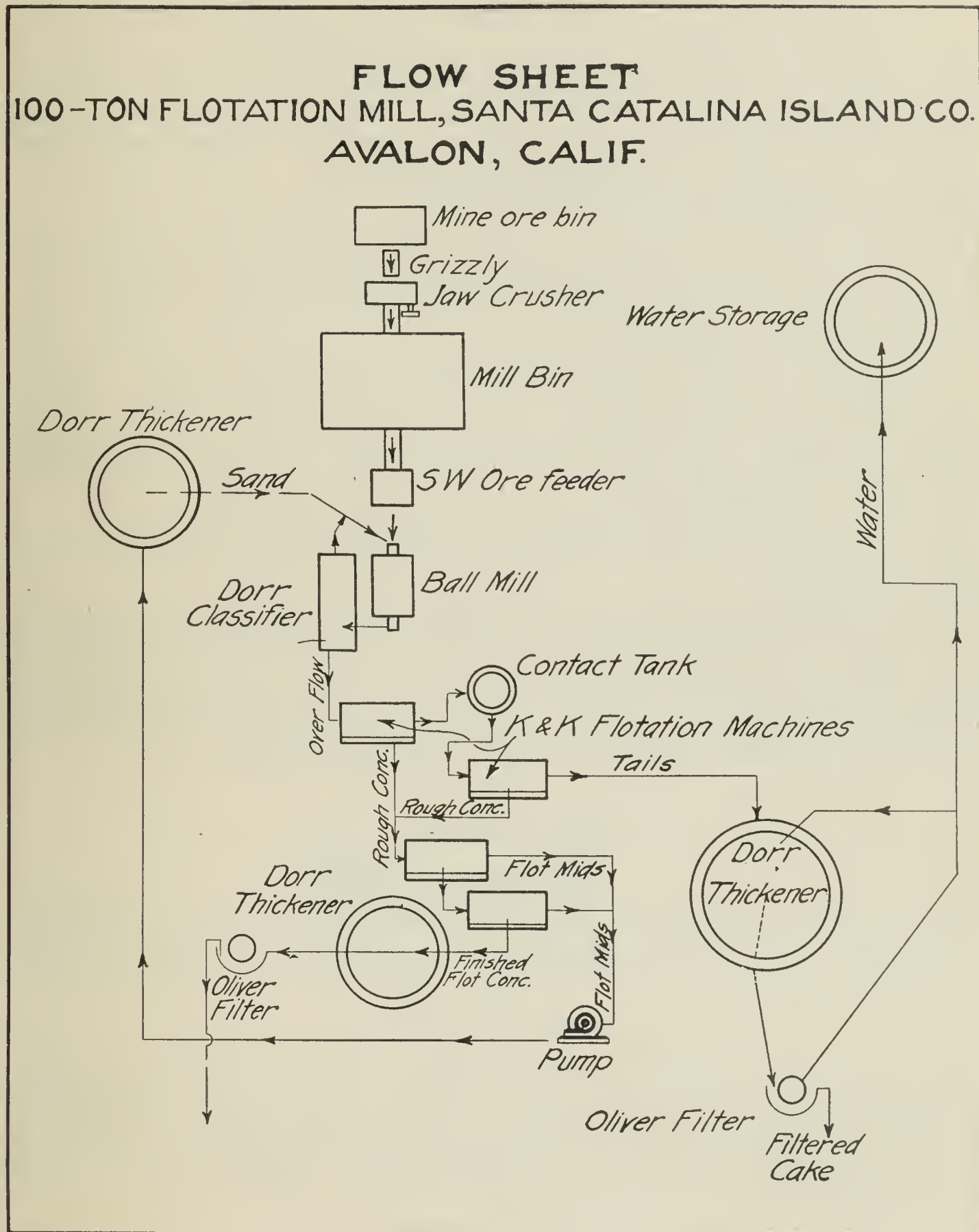
The vein is exposed along the face of the quarry. It strikes east and west, and dips 70° south, and occurs in andesite. A number of north and south shear zones cut off the ore-shoot, but do not displace the



100-ton flotation mill, White's Landing, Santa Catalina Island.

vein to any extent. The vein was first developed from the level of the quarry floor by Tunnel No. 1. About 50 feet in elevation vertically below these workings No. 2 tunnel has been driven east 489 feet on the vein. At 310 feet from the portal, a winze has been sunk on the vein to a depth of 250 feet. Eighty-five feet below this level No. 3 level has been driven on the vein a distance of 340 feet. No. 4 level is 85 feet below No. 3 level, and the vein has been developed for a distance of 200 feet. The ore-shoot developed is 150 feet in length, and has an average width of 4 feet. This ore-shoot trends to the east. The ore carries 9% zinc, $1\frac{1}{2}$ to 2% lead, and 3 ozs. in silver per ton. Ore is hoisted to No. 2 level to an ore pocket, and trammed to ore bins which dump over a grizzly. From here it goes to a sorting floor, where waste rock is sorted out, then to storage bins. The ore from this bin is hauled by truck to the main storage bins at Pebble Beach. From these bins, the ore from the Renton Vein and Quarry Mines is conveyed by belt conveyor to the main belt conveyor of the rock plant,

which carries it to a barge having a capacity of 250 tons. This barge is towed by tug to White's Landing, a distance of 5 miles, where it is unloaded by bucket crane into a truck, which hauls the ore to storage bins above the mill.



100-ton flotation mill, White's Landing, Santa Catalina Island.

The flotation mill at White's Landing has a capacity of 100 tons per twenty-four hours, at present writing treating 130 tons of the combined ore from Black Jack, Renton Vein and Quarry mines. The mill storage bins have a capacity of 500 tons. The ore from these bins is fed to a belt conveyor in the proportion of $\frac{1}{3}$ Black Jack ore and $\frac{2}{3}$ Renton Vein Mine and Quarry Mine ore.

The ore is treated by flotation and concentration. The mill equipment consists of 10" x 20" Blake crusher, Marcy ball mill in closed

circuit, with Dorr Simplex classifier; two Devereaux agitators, one for lead pulp, the other for zinc pulp; four 12-foot K. & K. flotation machines, two of which are used for lead product, and two for zinc product, consisting of primary and secondary roughers. One 6-foot K. & K. cleaner cell for lead float and two 6-foot K. & K. cleaner cells for zinc float; 4 Cottrell concentrators; battery of Wilfley pumps; 2 Dorr thickeners, one for lead concentrates, the other for zinc concentrates; 2 Oliver filters, one for lead and the other for zinc. Water supply for the mill is pumped from the ocean. Electric power for operating the mill is secured from the power plant at Avalon. Total horsepower required to operate mill is 225.

The ore treated at present carries from 7.2 to 8.7% zinc, 1.5 to 3.5% lead, and 3.5 ozs. silver per ton, the product produced being zinc concentrates, 45% zinc, 3.2% lead, and 11.5 ozs. silver per ton, and lead concentrates, carrying 55% lead, 8% zinc, and 93 ozs. silver per ton. Mill tails 2% zinc, 0.2% lead, and silver 0.9 ozs. per ton. Recovery is 80% of zinc, 82% of lead, and 80% of the silver. Production during 1926 was around 300 tons of zinc concentrates per month and 60 tons of lead-silver concentrates per month. Thirteen men are employed. Mr. Connor, superintendent.

The zinc concentrates are shipped to Belgium and lead-silver concentrates to the American Smelting and Refining Company's smelter at Selby, California.

Besides the above mentioned properties, considerable prospecting is under way on different parts of the island where vein outcrops show the presence of copper, lead and zinc ores. The principal areas being prospected are located southeast of Pebble Beach, and in the vicinities of Empire Landing, White's Landing and the isthmus.

NONMETALS.

CLAY.

In the vicinity of the Catherine Hotel and in other parts of the island are deposits, more or less limited in extent, that are suitable for the manufacture of tile.

MINERAL PAINT.

The occurrence of red and yellow ocher was noted along the oxidized croppings on the veins in Renton Canyon. Above No. 4 tunnel on the Renton Vein near the auto road to No. 3 tunnel, there is exposed a vein of red ocher that is 6 to 18 inches wide. Tests of the material are being made for its use as paint.

SOAPSTONE.

There is an extensive deposit of steatite located near the isthmus, at Empire Landing.

STONE.

The *Santa Catalina Island Company* owns and operates the Catalina Island Quarry located at Pebble Beach, one mile southeast of Avalon.

The quarry is 300 feet in elevation above sea level, and the rock being quarried is andesite. The broken rock is loaded from the quarry floor

by two steam shovels into two trains of cars, hauled by Plymouth gasoline locomotives, to a primary crusher located high above the rest of the plant.

The crushed stone is transported in barges a distance of 30 miles to bunkers of Graham Bros., Inc., Long Beach. The plant has a capacity of 1000 tons per day, with a monthly output of 30,000 tons. One hundred men are employed at quarry and crushing plant. J. Forest, general superintendent. The company also has a large stone quarry at Empire Landing.

The writer wishes here to acknowledge his appreciation of the courtesy and cooperation rendered by Mr. D. M. Renton and Mr. E. H. Pattison and Mr. Connor.

Bibl: State Mineralogist's Report X, pp. 277-281.



OIL FIELD DEVELOPMENT OPERATIONS.

By D. R. BUSH, State Oil and Gas Supervisor.

From October 31, 1926, to and including December 31, 1926, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
Coalinga Empire Oil Co.....	6	21	15	8	Coalinga
Zier Oil Co.....	1	20	14	N-6	Coalinga
KERN COUNTY:					
Bear State Oil Co.....	30	28	21	15	Belridge
Carneros Oil Co.....	31	28	21	3	Belridge
Carneros Oil Co.....	31	28	21	4	Belridge
Carneros Oil Co.....	31	28	21	7	Belridge
Standard Oil Co.....	31	30	25	Kern Co.	
				Lease 1 25	Elk Hills
Union Oil Co.....	26	30	24	Elk Hills 18	Elk Hills
Barnsdall Oil Co.....	32	27	28	1	Kern River
General Petroleum Corp.....	14	28	27	16	Kern River
General Petroleum Corp.....	14	28	27	17	Kern River
General Petroleum Corp.....	14	28	27	22	Kern River
General Petroleum Corp.....	14	28	27	23	Kern River
George F. Getty, Inc.....	22	28	27	Tegeler 1	Kern River
George F. Getty, Inc.....	22	28	27	Tegeler 9	Kern River
George F. Getty, Inc.....	22	28	27	Tegeler 10	Kern River
Gray Heirs.....	10	29	28	47	Kern River
Julian Petroleum Corp.....	26	27	27	Fannie	
				Higgins 1	Kern River
Skinner & Jasper.....	24	28	27	1	Kern River
Tarr & McComb, Inc.....	2	29	28	10	Kern River
Universal Consolidated Oil Co.....	32	26	21	46	Lost Hills
Universal Consolidated Oil Co.....	32	26	21	47	Lost Hills
Safeway Oil Co.....	20	30	22	3-A	McKittrick
Hugh B. Evans, Inc.....	35	32	23	14	Midway
General Petroleum Corp.....	32	31	24	Buena	
				Vista 10-A	Midway
Gore Oil Co.....	21	31	22	B-7	Midway
Gore Oil Co.....	21	31	22	B-16	Midway
Gore Oil Co.....	21	31	22	C-16	Midway
Gore Oil Co.....	21	31	22	C-21	Midway
Gore Oil Co.....	21	31	22	C-23	Midway
Gore Oil Co.....	21	31	22	C-25	Midway
Gralan Oil Co.....	4	32	23	6	Midway
Honolulu Consolidated Oil Co.....	8	32	24	29	Midway
Honolulu Consolidated Oil Co.....	8	32	24	69	Midway
Honolulu Consolidated Oil Co.....	8	32	24	79	Midway
Honolulu Consolidated Oil Co.....	6	32	24	88	Midway
Midlands Oilfields Co., Ltd.....	34	31	24	Thornber 8	Midway
Midway Peerless Oil Co.....	15	31	22	8-X	Midway
North American Oil Cons.....	32	31	24	8	Midway
North American Oil Cons.....	28	31	23	15	Midway
North American Oil Cons.....	28	31	23	18	Midway
Standard Oil Co.....	33	31	24	9	Midway
Standard Oil Co.....	5	32	24	10	Midway
Standard Oil Co.....	17	32	24	32	Midway
Standard Oil Co.....	17	32	24	34	Midway
Standard Oil Co.....	17	32	24	38	Midway
Standard Oil Co.....	31	31	24	63	Midway
Standard Oil Co.....	17	32	24	69	Midway
Union Oil Co.....	32	31	24	Buena Vista 5	Midway
Shell Co.....	9	27	28	Vedder 3	Mt. Poso
Midway Northern Oil Co.....	32	12	23	16	Sunset
The United Oil Co.....	32	12	23	Triangle 2	Sunset
Carolina Western Oil Co.....	7	29	21	1	Temblor
Milham Exploration Co.....	8	28	23	Kern 1-A	
Oildale Oil Co.....	13	27	18	1	

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
KINGS COUNTY:					
General Petroleum Corp.-----	30	23	19	Burbank 1	-----
LOS ANGELES COUNTY:					
California Well Drilling Co.-----	11	4	13	Del Amo	
Shell Co.-----	33	3	13	Estate 1	Dominguez
Shell Co.-----	34	3	13	Reyes 35	Dominguez
Union Oil Co.-----	33	3	13	Reyes 36	Dominguez
Standard Oil Co.-----	17	2	14	Callender 16	Dominguez
				Baldwin-	
				Cienega 32	Inglewood
Standard Oil Co.-----	17	2	14	Baldwin-	
				Cienega 33	Inglewood
Standard Oil Co.-----	16	2	14	Baldwin-	
				Cienega 81	Inglewood
Standard Oil Co.-----	17	2	14	L.A. Invest. 1 51	Inglewood
Standard Oil Co.-----	16	2	14	Stocker 9	Inglewood
California Petroleum Corp.-----	19	4	12	Harlow Kent 8	Long Beach
E. B. Campbell and H. R. McMillan	29	4	12		1 Long Beach
Tom J. Cannon-----	29	4	12		1 Long Beach
Graham & Loftus Oil Co.-----	19	4	12	Lightburn 3	Long Beach
Italo-American Petroleum Corp.--					
Modoc Petroleum Corp.-----	19	4	12	Italo 3	Long Beach
A. T. Jergins Trust-----	19	4	12		20 Long Beach
A. T. Jergins Trust-----	19	4	12		21 Long Beach
Macmillan Petroleum Products Co.--	29	4	12		5 Long Beach
J. E. O'Donnell-----	19	4	12	O'Donnell 57	Long Beach
Rainbow Petroleum Co.-----	19	4	12	Dutcher 1	Long Beach
Signal Syndicate-----	19	4	12		1 Long Beach
The United Oil Co.-----	19	4	12	Hass 11	Long Beach
Barnsdall Oil Co.-----	18	3	13	O'Dea 15	Rosecrans
L. F. Bassett and Blaine White-----	7	3	13		1 Rosecrans
Circle Oil & Gas Co.-----	23	3	14		1 Rosecrans
E. L. Cragen-----	7	3	13		1 Rosecrans
General Petroleum Corp.-----	18	3	13	Vaughn 5	Rosecrans
Julian Petroleum Corp.-----	35	2	14	Smith 1	Rosecrans
Kohlbusch & Johnston-----	7	3	13		5 Rosecrans
C. S. Akers-----	3	3	12		1 Santa Fe Springs
California Petroleum Corp.-----	6	3	11	Matern Three 9	Santa Fe Springs
F. W. W. Drilling Co.-----	5	3	11		1 Santa Fe Springs
Fred W. Roberts-----	5	3	11	S. F. Springs 1	Santa Fe Springs
C. C. M. O. Co.-----	9	4	14	Del Amo 61	Torrance
C. C. M. O. Co.-----	16	4	14	Del Amo 64	Torrance
C. C. M. O. Co.-----	16	4	14	Del Amo 65	Torrance
C. C. M. O. Co.-----	8	4	14	Del Amo 66	Torrance
C. C. M. O. Co.-----	15	4	14	Torrance 70	Torrance
Main Oil Co.-----	8	4	14		3 Torrance
Clearwater Petroleum Co.-----	16	3	12		2 -----
Haskell M. Greene-----	12	1	12		1 -----
Keck Investment Co.-----	18	4	17	Pena 1	-----
MONTEREY COUNTY:					
Petroleum Securities Co.-----	2	22	9	Aniotzbehere 1	-----
ORANGE COUNTY:					
Brea Canon Oil Co.-----	2	3	10		41 Brea Olinda
General Petroleum Corp.-----	6	3	9	Tonner 7-A	Brea Olinda
Shell Co.-----	1	3	10	Fisher 6	Brea Olinda
Shell Co.-----	2	3	10	Pico 6	Brea Olinda
Union Oil Co.-----	8	3	9	Olinda 3	Brea Olinda
Ahlburg Oil Corp.-----	10	6	11		5 Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	A. & T. 3	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Abel 2	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Davis 11	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Hume 4	Huntington Beach
California Petroleum Corp.-----	10	6	11	Brockman 1	Huntington Beach
California Petroleum Corp.-----	10	6	11	Farwell 1	Huntington Beach
California Petroleum Corp.-----	10	6	11	Fee 2	Huntington Beach
California Petroleum Corp.-----	10	6	11	Fee 3	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued.					
California Petroleum Corp.....	10	6	11	McLachlen 1	Huntington Beach
Coast Line Oil Co.....	10	6	11	1	Huntington Beach
Dell Oil Syn. No. 2.....	10	6	11	Behr 1	Huntington Beach
J. Paul Getty.....	10	6	11	Hunt. Beh. 3	Huntington Beach
J. Paul Getty.....	10	6	11	Hunt. Beh. 4	Huntington Beach
Golden Rod Oil Co.....	2	6	11	Golden Rod 2	Huntington Beach
W. A. Higgins.....	10	6	11	1	Huntington Beach
Jones Trust.....	10	6	11	1	Huntington Beach
Julian Petroleum Corp.....	10	6	11	Bogan 1	Huntington Beach
Julian Petroleum Corp.....	10	6	11	Lambert 3	Huntington Beach
Harry E. Macadam.....	10	6	11	1	Huntington Beach
McKeon Drilling Co., Inc.....	10	6	11	Fee 2	Huntington Beach
The McKeon Oil Co.....	10	6	11	Huntington 5	Huntington Beach
The McKeon Oil Co.....	10	6	11	Huntington 6	Huntington Beach
Olympic Refining Co.....	10	6	11	H. B. 9	Huntington Beach
Petroleum Securities Co.....	10	6	11	Gries 1	Huntington Beach
Petroleum Securities Co.....	10	6	11	Lewis 1	Huntington Beach
Richardson Oil Co.....	10	6	11	9	Huntington Beach
Fred W. Roberts.....	10	6	11	H. B. 2	Huntington Beach
San Martinez Oil Co.....	11	6	11	Hanke 1	Huntington Beach
Shoreline Oil Co.....	10	6	11	2	Huntington Beach
Standard Oil Co.....	34	5	11	Bolsa 27	Huntington Beach
Standard Oil Co.....	34	5	11	Bolsa 28	Huntington Beach
Standard Oil Co.....	10	6	11	Heffner 1	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 18	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 20	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 21	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 22	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 23	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 24	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 3	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 4	Huntington Beach
Sun Oil Co.....	10	6	11	11	Huntington Beach
Superior Oil Co.....	10	6	11	Gillette 6 2	Huntington Beach
Topeka Oil Co.....	10	6	11	11	Huntington Beach
Transport Oil Co.....	10	6	11	16	Huntington Beach
Transport Oil Co.....	10	6	11	17	Huntington Beach
Travis Drilling Co.....	10	6	11	H. B. 1	Huntington Beach
The United Oil Co.....	10	6	11	Buck 2	Huntington Beach
The United Oil Co.....	10	6	11	Dike 1	Huntington Beach
The United Oil Co.....	10	6	11	Gay 1	Huntington Beach
The United Oil Co.....	10	6	11	Stott 1	Huntington Beach
United States Royalties Co.....	10	6	11	Lambert 1	Huntington Beach
H. L. Whiston.....	10	6	11	Geick 1	Huntington Beach
White-Smithson Trust.....	10	6	11	Schroeter 1	Huntington Beach
Hudson D. Wilcox.....	10	6	11	1	Huntington Beach
General Petroleum Corp.....	33	3	9	Hugo 6	Richfield
Union Oil Co.....	28	3	9	Ayers &	
				Parsons 5	Richfield
Union Oil Co.....	30	3	9	Chapman 26	Richfield
Union Oil Co.....	29	3	9	Morse 7	Richfield
Union Oil Co.....	28	3	9	Thompson &	
				Goodwin 8	Richfield
Marland Oil Co.....	11	5	12	Bixby 5	Seal Beach
Marland Oil Co.....	3	5	12	Bixby 6	Seal Beach
Marland Oil Co.....	3	5	12	Bixby 7	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 8	Seal Beach
Marland Oil Co.....	10	5	12	Selover 2	Seal Beach
Marland Oil Co.....	3	5	12	Selover 3	Seal Beach
Pan American Petroleum Co.....	3	5	12	Naples 1	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 3	Seal Beach
Standard Oil Co.....	11	5	12	San Gabriel 4	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 5	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 6	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 7	Seal Beach
Standard Oil Co.....	10	5	12	San Gabriel 8	Seal Beach
Gaston A. Bastanchury.....	30	3	10	1	
General Petroleum Corp.....	19	5	11	Lomita 1	

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
SAN LUIS OBISPO COUNTY:					
Brinkman Oil Co.-----	22	31	21	1	-----
E. T. Edwards-----	22	31	21	5	-----
Reliance Producers, Inc.-----	34	25	15	1	-----
SANTA BARBARA COUNTY:					
R. & G. Oil Co.-----	30	9	32	18	Cat Canyon
Miley Oil Co.-----	3	4	29	1	-----
SANTA CRUZ COUNTY:					
Cala-Cruz Oil Corp.-----	16	11	2	2	-----
Gerard Ryzek-----	14	11	2	1	-----
VENTURA COUNTY:					
New Hope Oil Co.-----	33	4	18	1	Piru
Temescal Petroleum Co.-----	3	4	18	Temescal 4	Piru
San Pedro-Pt. Fermin Oil & Gas Co.---	13	4	21	2	Santa Paula
Oak Ridge Oil Co.-----	18	3	20	Willard 21	South Mountain
Union Oil Co.-----	13	3	21	Snyder 2	South Mountain
General Petroleum Corp.-----	21	3	23	Barnard 9	Ventura
General Petroleum Corp.-----	28	3	23	Barnard 12	Ventura
General Petroleum Corp.-----	21	3	23	Hisey 1-A	Ventura
Shell Co.-----	29	3	23	Taylor 16	Ventura
Shell Co.-----	28	3	23	Taylor 18	Ventura
Star Petroleum Co.-----	13	3	23	Star Canet 1	Ventura
E. A. Parkford-----	5	3	18	1	-----



SPECIAL ARTICLES.

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of 'Mining in California.'

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

HYDRAULIC MINING COMMISSION.

Following presentation to the Legislature of the report of the Hydraulic Mining Commission provided for in Chapter 270, Statutes of 1925, a bill was introduced in the Assembly (A. B. 681) by Mr. H. C. Cloudman to appropriate \$200,000 to be used for the purchase of damsites and other necessary land to restrain tailings from hydraulic mining and operations. This would have enabled the testing of rock conditions at the damsites by drilling and the gathering of other necessary engineering data required before constructing the dams. The bill passed the Assembly, but failed by one vote in the Senate. However, the cause is not altogether lost, as much educational work has been accomplished, though much yet lies ahead before the goal is reached.

The United States Senate Committee on Commerce has requested the Chief of Engineers, U. S. Army, and he in turn has ordered of the California Debris Commission an engineering report on the several feasible damsites, with calculated capacities and costs; also estimated quantities of workable gravels that might be hydraulicked. Such work is authorized by and under the provisions of Sections 5 and 25 of the Caminetti Act. Had the Cloudman bill succeeded in passing there would have been made available to the California Debris Commission ample funds to carry on the survey and prepare their report within the coming biennium. As it stands, it may be longer delayed.

There having been only a limited edition printed of the report of the Hydraulic Mining Commission, primarily for the members of the legislature, and in consequence of numerous requests received by the State Mining Bureau for copies of this report, the State Mineralogist has deemed it advisable to reprint it in the current issue of MINING IN CALIFORNIA.

LLOYD L. ROOT,
May 1, 1927.

REPORT

OF THE

Hydraulic Mining Commission

UPON THE FEASIBILITY

OF THE

Resumption of Hydraulic Mining
in California

A REPORT TO THE LEGISLATURE OF 1927

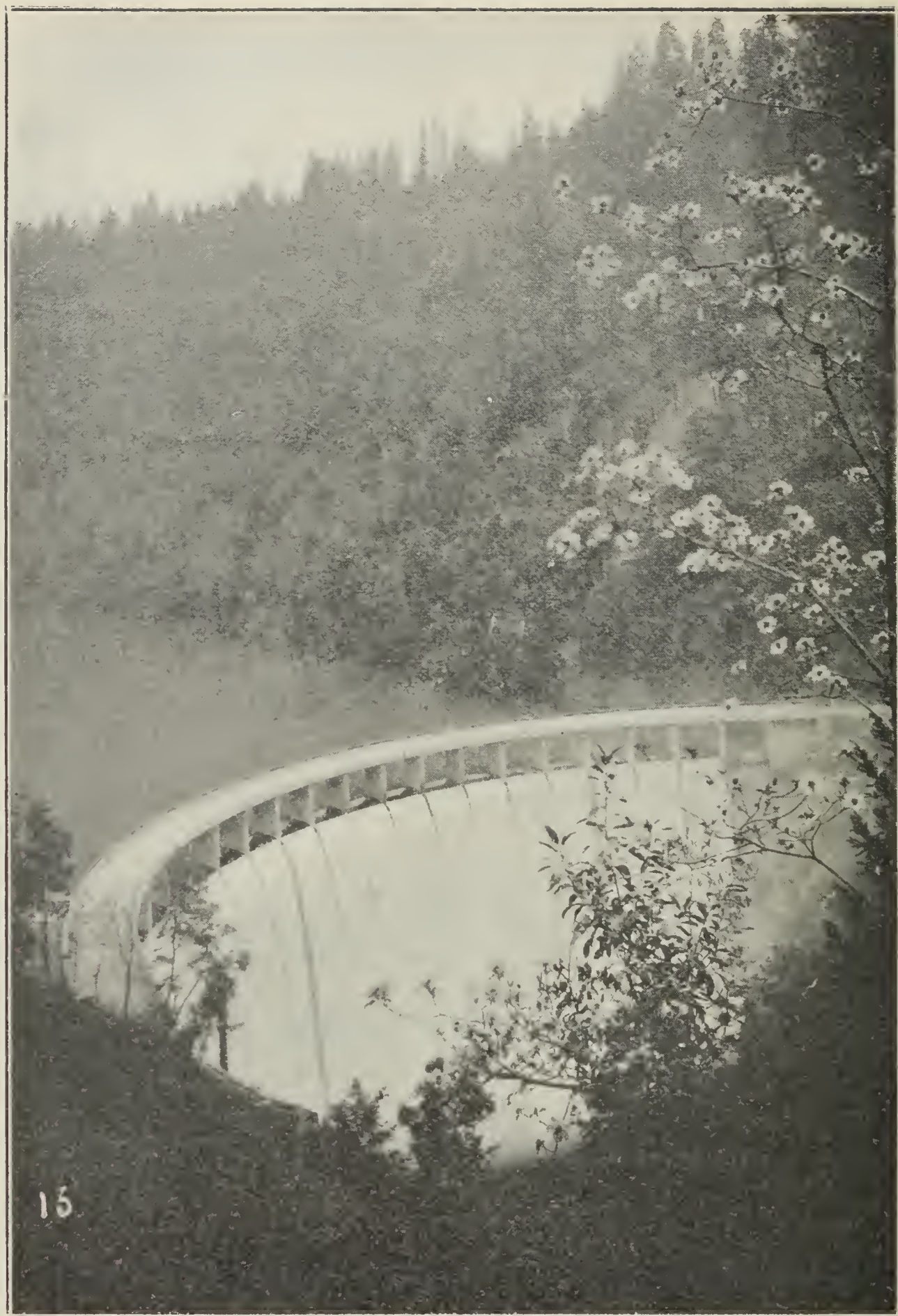


Photo by Arthur Jarman.

BULLARD'S BAR DAM.

On the North Fork of the Yuba River. Erected by Yuba River Power Company; completed January, 1924; effective height, 175 feet; length of crest, 520 feet; impounds 31,600 acre-feet of water. 10,000 horsepower is developed here and sold to the Pacific Gas and Electric Company for distribution. Mining is allowed behind this dam upon payment of a charge per cubic yard of gravel. Photo taken April 2, 1926. Flow of water, 1700 second-feet or 68,000 miner's inches. Water perfectly clear—suspended matter is less than 1 part in 10,000,000 of water.

LETTER OF TRANSMITTAL.

February 17, 1927.

TO THE MEMBERS OF THE LEGISLATURE,
State of California,
Session of 1927.

Pursuant to the provisions of Chapter 270, Statutes of 1925, calling for an investigation of the feasibility of any plan or plans whereby hydraulic mining can be resumed in California, this Commission, consisting of the state mineralogist and the surveyor general, engaged Mr. Arthur Jarman, mining engineer, to undertake the field work and prepare the technical report.

Hydraulic mining is regulated and controlled by the California Debris Commission under federal statute. That Commission offered their collaboration and assistance in the investigation, and have made surveys, capacity estimates and preliminary estimates of costs. Complete and cordial cooperation was maintained throughout the progress of the work; and our thanks are hereby tendered to Major C. S. Ridley, Secretary, and the other members of the California Debris Commission.

The investigation shows that hydraulic mining may be resumed, not only without fear of damage to farming and other interests, but with positive benefit to them, provided that impounding dams be constructed at strategic points, as shown on the map of the area under consideration. Preliminary estimates show that the erection of three dams and the purchase of storage in a fourth dam at a total cost of \$2,405,000 would enable this industry to be resumed on the Bear, American and Yuba rivers.

Mr. Jarman reports that the available water will only suffice for one-fourth of the activity of the early '80's and that the shortage of water will mainly restrict work on gravels above the average in gold content. His forecast is an annual output of gold only one-seventh that formerly obtained from the district described. Approximately 10,000,000 cubic yards, estimated to yield \$1,156,000, would be mined annually compared with 38,610,000 cubic yards in 1880, estimated to have yielded \$8,000,000.

To restrain the gravel from mines in this district suitable sites for dams have been selected and surveyed and at each of these the rock conditions must be tested by drilling. Some detail surveys are also needed to supplement and check the data already obtained. This work is required on Lower Bear River site, two sites on the Middle Fork of the American River, two sites on the North Fork of the American River, and at the Narrows site on the Main Yuba. Six sites in all and possibly a seventh to enable a wise choice to be made for four dams.

This work is estimated to cost from \$50,000 to \$60,000 and until this preliminary engineering work has been carried out, it is not possible to decide the exact position for the construction of any dam or ascertain its cost closely enough to call for bids for its construction.

RECOMMENDATIONS.

State Legislation Required.

Assemblyman H. C. Cloudman was responsible for the bill that created this commission of investigation, and he has already introduced Assembly Bill No. 681, the object of which is to provide for the above work to be done.

Your commission recommends that the preliminary engineering to be done under this bill be done by the engineers of the California Debris Commission, as the Commission must certify to the utility and practicability of the storage sites, as provided in section 5 of the California Debris Commission Act.

The plans prepared for the construction of dams will be coordinated with those for the development and conservation of the water resources of the state, as outlined in Bulletin No. 12 of the Department of Public Works, recently issued. The dam at the Narrows will be so constructed that it may subsequently be raised to the maximum practicable height as forecast in that bulletin.

Upon receipt of favorable reports upon these damsites and of estimates of debris that may be allowed to be mined behind dams built thereon, and upon receipt of estimates of the costs of such dams this commission recommends that the balance of the moneys remaining unexpended under the appropriation named in this bill be utilized for the purchase of lands required as damsites and as areas to be flooded.

When estimates of the costs of dam construction on the Bear River and the North Fork and Middle Fork of the American River have been received, further legislation will be required to provide money for their construction, and vesting the debris storage in the California Debris Commission. Preliminary estimates indicate that \$905,000 will suffice for these dams, including the \$300,000 expenditure upon the damsites.

When the site at the Narrows on the Main Yuba has been drilled and plans for the proposed dam confirmed as suitable by the California Debris Commission and the allowable yardage of debris calculated therefor, legislation will be needed to provide a sum of \$1,500,000 to purchase the total debris storage that can be obtained there by the erection of a dam to a crest elevation of 520 feet. This is in accordance with the letter printed on p. 35 of this report. This dam will provide a large amount of storage at a low price, which will enable the large low-grade gravels of the Yuba to be worked. No other dam sites examined showed costs that would enable these gravels to be worked, as revenue from power developable was too small in each case.

The total expense anticipated is therefore \$2,405,000, and should be provided one-half by the State and one-half by the Federal Government as was done for the protection work on the Yuba above Marysville quoted on p. 13 of this report.

Federal Legislation Required.

Your Commission recommends Mr. Jarman's suggestions that legislation be introduced in Congress to enable the California Debris Commission to purchase debris storage in a dam in lieu of actually building a dam.

Also to amend the manner of charging a mine for restraining its debris in such a dam, or in a dam built by the Commission, by making a charge per cubic yard of debris discharged from the mine in such manner that it will be restrained in whole or in part by the dam, credit being given for boulders and material permanently stacked at the mine.

Also to provide that the charge to be made per cubic yard shall be calculated so that the capital cost of the dam shall be returned by the mining of the yardage of debris estimated by the California Debris Commission as restrainable by the dam. The total cost of the dam would be divided by the allowable yardage of debris in order to ascertain the charge to be made per cubic yard. The existing provision of a charge of 3 per centum of the gross proceeds of a mine is much too small, producing only one-third of the cost in most cases.

The sections of the Caminetti Act which provide for the protection of river channels and lands adjacent thereto should remain unaltered, and the above are the only recommendations made that affect this Act.

Benefits to Be Obtained by the Adoption of the Above Program.

1. Revival of Nevada and Placer counties, due to useful and productive work, requiring the employment of a considerable number of men in mining and other work dependent upon it.

2. Benefit to Marysville, Sacramento and San Francisco, due to orders for piping and mining machinery, materials and supplies, timber and general merchandise.

3. Development of additional water supplies for mining that will be stored in the higher regions and released as used for mining. This will assist all plans for water conservation at lower elevations, and tend to reduce salinity in the lower reaches of the Sacramento River.

4. The effects of the above will be felt as soon as the construction of dams is started. The miners will prepare for work by driving tunnels and repairing sluices and refitting their mines as soon as it is assured that debris will be stored at a reasonable price so that hydraulic work may be resumed with due protection to farm lands below.

5. Natural debris will likewise be prevented from being carried downstream and this will benefit the navigable channels by reducing the amount of dredging required. Dredging on the Sacramento River costs 6 cents per cubic yard, and the cost of restraining debris by a dam is less than one-third of this.

6. The Narrows Dam near Smartsville will render available considerable power and also water. The latter will be at an elevation of 520 feet, enabling it to be distributed over a large area of land with great benefit to the district below.

Respectfully submitted.

LLOYD L. ROOT,
State Mineralogist,
W. S. KINGSBURY,
Surveyor General,
Commissioners.

CALIFORNIA HYDRAULIC MINING COMMISSION—1925.

February 1, 1927.

THE HON. W. S. KINGSBURY, Surveyor General,
LLOYD L. ROOT, State Mineralogist,

Commissioners.

GENTLEMEN: This report has been delayed owing to the time required for calculating the impounding capacities and construction costs of dams upon various damsites considered. The figures were received from the California Debris Commission on January 26, 1927. They are estimates of impounding capacities and preliminary estimates of the costs of dam construction. They are given on pages 36 and 37.

The surveys and calculations involved much careful and detailed work and without this cooperation on the part of the California Debris Commission it would have been impossible for me to have formulated for your consideration the plan now submitted. In these surveys and estimates we are particularly indebted to Mr. R. L. Egenhoff, Engineer to the California Debris Commission, and to Mr. Harold F. Grey, in charge of the survey parties.

Because dams for the retention of hydraulic mining debris should be constructed, maintained and administered by the California Debris Commission to insure the protection of navigable channels and lands below, and because of the benefits to the state by the revival of mining and other industries involved, it is recommended that the State and Federal Government combine to provide the dams recommended.

Payments made by miners for the retention of their debris by these dams will constitute a revolving fund for the continuance of their work under the control of the California Debris Commission under the provisions of sec. 23 of the Caminetti Act of 1893. (See p. 16 of this report.)

The recommendation now made is that a sum of \$300,000 be appropriated for preliminary engineering necessary to obtain precise data upon those damsites that give promise of favorable results upon Bear River, and the North Fork and Middle Fork of the American River, and to acquire the lands affected. Detail surveys are required on these sites and drilling to ascertain rock conditions to enable final estimates of dam construction to be calculated. If this work be started in the spring of 1927 it could be completed in that year. The preliminary estimates just completed indicate that a sum of approximately \$905,000 will provide dams for twenty years of hydraulic mining on these streams. The gold production from this work is estimated to exceed \$8,000,000 in that time. Payments by miners for debris stored during this period will automatically provide capacity for further work.

In addition to the above it is recommended that storage be purchased in a dam to be constructed by a private corporation at the Narrows site on the Main Yuba River. The quantity offered for purchase is the

total debris storage of a dam to be erected to a crest elevation of 520 feet above sea level, some water space being reserved for hydroelectric power and irrigation purposes. The calculation of debris capacity will be subject to approval by the California Debris Commission in the usual manner. Preliminary estimates show 350,000,000 cubic yards and a cost of \$1,500,000. The balance of the cost will be carried by the power and irrigation features of the project. This is a much greater amount of storage than could be obtained for the same money at other sites surveyed on the Yuba. It will enable mines to work on both the South and Middle Yuba rivers. The production for 20 years is estimated at \$14,000,000 from about 130,000,000 cubic yards of gravel. At the end of the 20 years there will still be space in this reservoir for another 20 years of work at the same rate.

The storage would be vested in the California Debris Commission and would be paid for by mines operating behind the dams according to the yardage of gravel washed each season, as measured at the mine, credit being given for material permanently stacked at the mine, the surveys being made by the Commission or as directed by the Commission. Power to purchase debris storage in lieu of erecting a dam would have to be added to the Caminetti Act by Congress. It is also necessary to enact a new method of charging for impounding debris according to the actual volume of gravel discharged from the mine. The act now specifies a charge of 3 per centum of the gross output of each mine. This is so small that the dams would never be paid for.

It is now suggested that the charge for each river be determined separately, the basis being the return of the capital outlay by the time the allowable debris has been worked above the dam. In this report the dams have been calculated to allow 20 years' work. In the case of the Main Yuba River at the Narrows it would take 40 years of work at the rate calculated but the development of extra water supplies and improvements in methods would speed up this work and reduce the time. 300,000,000 cubic yards at \$1,500,000 would be 0.5 cent per cubic yard which is low enough to insure the working of these low grade gravels. The determination of impounding costs must await the exact estimates of construction costs which can not be made until drilling has been carried out at each dam site.

The preliminary estimates of the above plan total \$2,405,000. This initial outlay will enable hydraulic mining to be revived on the Bear, American and Yuba rivers to an annual production exceeding \$1,150,000, and will provide for the gravel that will be mined in the first 20 years, and for a much longer period on the Middle and South Yuba rivers. The cost of the dams and purchased storage will be returned by debris impounding fees, which, under the Caminette Act, are used for maintenance and to provide additional storage as required.

This plan is feasible and can be carried out at much below the capital cost involved in any other plan that has been suggested as a solution of the troubles of the hydraulic miner. It deals only with gravel that can be mined with the existing water supplies.

Respectfully submitted.

ARTHUR JARMAN,
Secretary and Engineer to the Hydraulic Mining Commission.

ACKNOWLEDGMENTS.

Grateful acknowledgment is made to those who assisted in the gathering of data required and in facilitating the inspection of the gravels.

To Messrs. James D. Stewart of Auburn; Chester Bowman, John Ferguson and James Nelson McCormick of Forest Hill; Lyman Gilmore of Iowa Hill; Thomas B. Brady of You Bet; W. Maguire and W. W. Waggoner of Nevada City; Theodore Larsen and D. E. Bleakley of Washington and Omega, for assistance when inspecting the gravels.

For data and reports upon various properties thanks are tendered to Messrs. Malcolm Lindsay of Denver; J. Henry Schnitzel of Lead, South Dakota; F. A. Goodale of Los Angeles; James D. Stewart of Auburn; W. Maguire and W. W. Waggoner of Nevada City.

To Mr. Ernest A. Bailey, Flood Engineer, Sacramento, for enabling me to visit the flood control works from the mouth of the Sacramento River to the Tisdale Weir, most of this in his company, with the benefit of obtaining information on the flood control problem at first hand.

To Mr. W. T. Ellis, Levee Commissioner, of Marysville, for inspecting and explaining the flood protection system around Marysville.

To Mr. Paul Bailey, State Engineer, for cordial cooperation concerning the relations of the proposed plan to that proposed for the conservation of the waters of the state.

To Mr. Edward Hyatt, Chief, and Mr. Everett W. Bryan, Assistant Chief, of the Division of Water Rights, for information on the waters appropriated from rivers.

To the California Debris Commission for the preliminary estimates of costs of dams, without which this report could not have been made, and for the preparation of the map. Also, for the cordial manner in which this work has been carried out with full cooperation to make it of greatest benefit to the hydraulic mines of the district surveyed. For planning this work and supervising it, thanks are especially due to Mr. R. L. Egenhoff, Engineer to the California Debris Commission, also to Mr. Harold F. Grey, in charge of the field parties, and to both these gentlemen for calculations of capacities and costs.

To the Hydraulic Mining Commission, the Honorable W. S. Kingsbury, Surveyor General, and Mr. Lloyd L. Root, State Mineralogist, I wish to express my appreciation of the courtesies extended to me and for freedom of action in the conduct of the investigation.

ARTHUR JARMAN.

AN INVESTIGATION OF "THE FEASIBILITY OF ANY PLAN OR PLANS WHEREBY HYDRAULIC MINING OPERATIONS CAN BE RESUMED IN THIS STATE."

REVIEW OF THE PROBLEM.

Production in the Old Days.

As nearly as can be ascertained, in the palmy days of hydraulic mining the annual production reached \$15,000,000 and averaged \$10,000,000 for about thirty years immediately prior to 1884, when injunctions were issued to prevent the discharge of debris into the rivers.

Present Production.

By 1908, the total production for drift, hydraulic and other gravel mining had fallen below \$1,000,000 due to the stoppage of hydraulic mining and the partial exhaustion of the richer drift mines.

In 1924, hydraulic mines, for the whole state, produced only \$60,195* and in 1925 produced \$175,345.

For the six years 1920 to 1925 hydraulic work averaged \$122,114 per annum, and of this amount less than \$60,000 was produced by counties that drain into the Great Valley of California. More than half of it was from counties that are not subject to restrictions because their rivers discharge into the ocean without navigable channels.

The drop from \$10,000,000 to \$122,114 per annum shows that hydraulicking has almost ceased and unless substantial assistance be given at an early date this industry will die as the remaining water resources will gradually be taken for other purposes.

Possibility of Reviving Hydraulic Mining.

A general revival is impossible because of the altered conditions of the times and because much of the water supplies that formerly belonged to hydraulic undertakings have been acquired by power and irrigation interests. Making allowance for these factors, there still remain some of the largest auriferous gravel deposits known to the mining world, and **the only process by which they can be worked at a profit is hydraulic mining.** A portion of the former water supplies is still available and would enable an industry to be built up with an annual production estimated at \$1,156,950, so that in the next 20 years gold would be produced to a total value of over \$23,000,000, but to accomplish this **the debris must be impounded at a low cost, otherwise more than one-half of the gravel would be unprofitable to work,** being of low grade. The provision of a substantial concrete dam on each of the main streams affords the only hope of securing impounding capacity at low cost, each dam serving several mines.

*See the returns given in Mineral Resources of the United States, 1924, Part I, by Jas. M. Hill, p. 212.

To accomplish this it will be necessary to activate the Caminetti Act in its entirety.

This act was passed by Congress in 1893, its proper title being "An act to create the California Debris Commission and regulate hydraulic mining in the State of California," approved March 1, 1893.

The condemnatory sections were utilized on the passage of the act. These provide more severe penalties than the state laws.

The permissive sections were also put into action. These allow the miner to build a dam and on its approval by the commission he may mine up to the limit of the capacity of the dam. Miners or others may combine to erect a dam to serve more than one mine. This provision has also been used and is in action.

The protective section, or the protective provision of section 25 provides that the commission shall build dams to prevent mining debris from injuring the navigable rivers. This provision was utilized between 1900 and 1910 by the erection of barriers on the Yuba and a "cut" and dam at Daguerre Point about nine miles above Marysville. This was done to protect the channels at Marysville and the adjacent farm lands, a matter of urgency because of the large quantity of debris in the channel. This work cost \$661,824.14; one-half was paid by the state and one-half by the federal government.*

Up to July 1st, 1923, the federal government has expended	\$398,268.67
The State has expended-----	398,656.39

A total of -----	\$796,925.06**
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The vitalizing sections, however, have lain dormant and unused. These provide that dams shall be built by the commission "when appropriations are made therefor by law" and that for the retention of debris by such dams the miner "shall pay a tax of 3 per centum of the gross proceeds" of his mine so worked.

Nothing has been done under these sections to provide dams for the resumption of hydraulic mining, nevertheless they point out the way to revive hydraulic mining, by enabling the mines of each district to work behind a common dam. The creation of the California Debris Commission, charged with the specific duties of examining dam sites and erecting dams when moneys are provided for them, simplifies the problem.

The recommendations that are made result from studies of dam sites and of gravels that would be benefited by dams in these positions. An account of this investigation follows the recommendations, and a short history is given of the growth and decline of hydraulic mining, followed by details of the principal gravels that are workable on each river under the plan now proposed.

The California Debris Commission's report upon dam sites, with their impounding capacities and preliminary estimates of costs is printed verbatim. The map that accompanies this report was prepared by them and on it are shown the chief gravels that are workable.

* See 1910 Report of Chief of Engineers, U. S. Army, pp. 1010-1011.

**See letter from the Reclamation Board of California to the Hon. C. F. Curry Feb. 1924, p. 54.

RECOMMENDATIONS.

1. As a result of surveys and calculations, five damsites were found to be unsuitable because of high cost per cubic yard of impounding capacity. Six showed promise of reasonable cost per cubic yard of gravel and it is recommended that detailed surveys be made of these and that drilling be done to ascertain rock conditions. If a start be made in the spring it would enable this work to be completed by the end of the year so that costs may be calculated and plans and specifications drawn up. This preliminary engineering is essential before reliable estimates for dam construction can be made. Under the most favorable circumstances and if funds were already available, no construction work would be possible before 1928.

2. The site at the Narrows on the Main Yuba requires drilling only to ascertain closely the cost of construction, but a low cost per cubic yard is assured from preliminary estimates. In this case revenue from power production and the sale of water for irrigation enables low cost to be obtained.

3. It is recommended that a sum of \$300,000 be provided for preliminary engineering and for the purchase of damsites finally recommended.*

4. From \$50,000 to \$60,000 is estimated as sufficient for preliminary engineering on the seven sites to be examined and the balance of the \$300,000 should cover the purchase of sites and lands when the most suitable sites have been determined. The engineering work now recommended will be a continuation of that done by the commission in 1926-1927.** The money required should be made available to supplement the annual congressional appropriation of \$15,000 which covers the ordinary work of the commission and does not go far when special work of this kind is undertaken.

Discussion of These Recommendations.

When final estimates have been made, appropriations will be required to enable dams to be built and debris impounding capacity to be purchased by the California Debris Commission according to Table I which shows the output estimated for twenty years of work under this plan and the cost of debris storage according to the preliminary estimates, the total being \$2,405,000 for the five rivers.

*Provided for by Assembly Bill No. 681, introduced into the State Assembly by Harold C. Cloudman, member for the 40th district, proposing to appropriate \$300,000 for these purposes.

**The California Debris Commission is charged with the duty of examining dam sites under the Caminetti Act which says: "That it shall further examine, survey, and determine the utility and practicability, for the purposes hereinafter indicated, of storage sites. * * *"

TABLE I.
Estimate of Dams Required for Twenty Years' Work.

River	Amount of gravel estimated to be washed in 20 years (cubic yards)	Debris capacity of dam (cubic yards)	Preliminary estimates of total cost of dam	First cost in cents per cubic yard of gravel	Name of dam site	Particulars of dam
North American..	23,000,000	21,000,000	\$470,000	¹ \$2 24	Owl Creek....	Dam crest 137 feet above low water.
Middle American..	13,280,000	22,000,000	125,000	¹ 0 94	Mammoth Bar	Dam crest 45 feet above low water.
Bear.....	26,510,000	21,000,000	310,000	1 47	Lower Bear River.....	Dam crest 143 feet above low water.
South Yuba.....	85,392,000	preliminary	estimate			This dam site is below the junction of the Middle and South Yuba and will serve both streams. Dam to be built to 220 feet above low water.
Middle Yuba.....	52,000,000	² 350,000,000	³ 1,500,000	under 0 50	Narrows.....	
Totals.....	200,182,000	400,000,000 +	\$2,405,000	-----	-----	

¹ Another site is to be examined that should give lower cost.
² This figure not yet checked by the Debris Commission.
³ For purchase of total debris storage capacity allowable.

The building of dams by the California Debris Commission is provided for by the act of 1893 which created the commission, but the alternative of purchasing debris impounding capacity in a dam built or proposed to be built in accordance with the commission's requirements has not been included, and an amendment would be needed to enable debris impounding capacity to be purchased by the commission. Table II shows that the charge of 3 per centum of the gross output of a mine for impounding its debris would not repay the first cost of the proposed dams. To accomplish this the method of charging should be changed by an amendment providing for a charge per cubic yard of gravel washed, credit being given for material stacked and retained at the mine.*

Table II also shows the charges per cubic yard required to return the capital cost by the time that the debris capacity of the dam has been mined.

*This is discussed further on page 17.

TABLE II.

Costs of Dams Compared with Debris Payments Calculated at Three Per Cent of the Probable Gross Yield and Compared with Debris Payments at Rates per Cubic Yard That Will Return the Costs Results for Twenty Years' Work.

River	Cubic yards debris	Dam payments at proposed rate per cubic yard	Suggested rate in cents per cubic yard	Dam payments at three per cent of yield	Cost of dams	Gold production expected
North American.....	23,000,000	\$515,000	*\$2 24	\$79,200	\$470,000	\$2,640,000
Middle American.....	13,280,000	125,000	0 94	40,416	125,000	1,347,200
Bear.....	*(21,000,000)	310,000	1 47	125,010	310,000	4,167,000
	26,510,000 expected					
South Yuba.....	85,392,000	2686,960	0 50	449,544	3,090,000	9,784,800
Middle Yuba.....	52,000,000				745,000	-----
Main Yuba ¹	-----				1,150,000	5,200,000
					1,500,000	-----
Totals.....	200,182,000	\$1,636,960	-----	\$694,170	\$2,405,000	\$23,139,000

*An additional site to be examined in each case with the object of obtaining lower cost on the North Fork of the American River, and a larger capacity on Bear River.

¹ Same figures as for Middle and South Yubas with some gravel below Freemans not estimated.

The three dams originally considered on the South and Middle Yubas would have cost a total of \$4,895,000 which is too high for work to be possible behind them on low grade gravels. Substitute for these three the purchase of storage on the Main Yuba at the Narrows for \$1,500,000.

² Payments for the first twenty years only.

Payments for Impounding Debris From Mines.

A charge per cubic yard of debris discharged into the stream or channel is recommended. The act of 1893 stipulates 3 per centum of the gross production as payment for impounding debris. Unless the gravels are richer than 15 cents per cubic yard, the payments will only produce one-half cent per cubic yard. It has already been shown that the cost of providing impounding capacity is higher than this, leaving out of account the loss of interest on capital expended. Revenue derivable from water used for irrigation or for power production is discussed on p. 26, and is small for the dams considered because the effective height is small.

The dams proposed must develop storage capacity at low cost, otherwise the plan will not restore hydraulic mining because mining must pay the cost of storing the debris. Any plan which does not provide that mining shall pay for the actual storing of the debris is economically unsound. In the Caminetti Act, section 23 provides that "All sums of money paid into the treasury under this section shall be * * * expended by the said commission * * * in the construction and maintenance of such restraining works and settling reservoirs as may be proper and necessary."

In this manner payments for the storage or restraining of debris are utilized to provide new storage capacity as well as to maintain old dams, and if these payments equal the capital cost we shall have a revolving fund that will continue to provide the industry with settling reservoirs. But if the payments be insufficient to return the cost of providing dams, then the fund will diminish until extinguished.

The method of charging for this service is immaterial to the argument, but any amendment would require action by Congress.

The first calculations made for this report were based upon 20 years of work under the 3 per centum payments, and an inspection of

Table II shows that 3 per centum would be inadequate and the revolving fund would quickly disappear. If all gravels were charged the same rate per cubic yard the payments would be sufficient on some rivers and insufficient on others. It appears most logical to determine the charge at each dam irrespective of the charge made at any other dam because conditions differ on the various rivers.

Provision should be made for the receipt of revenue derivable from the sale of water for power production or for irrigation, and this should be credited to the state.

It is impossible to estimate exactly the yield from the gravels, therefore it is futile to calculate greater revenue derivable from a greater percentage charge. A charge per cubic yard of debris discharged into the stream or channel is rational, and it is suggested that this charge be based upon the return of the cost of the dam by mining the quantity of debris allowed to be mined behind it.

Where there is a large percentage of heavy boulders there is no sense in encouraging the discharge of such material into the water courses. In many cases it would be cheaper to stack this on the bedrock of the mine, using an electric derrick. When this is done, the survey should make an allowance for the quantity so retained on the bedrock of the mine. Such heavy material would never reach the dam but might reach the main water courses; stacking it at the mine should be encouraged and not penalized. If charged for as though retained by the dam the effect is to raise to a high figure the charge per cubic yard mined. This is not equitable, and may prevent the earning of a profit.



Photo by Arthur Jarman.

DAMSITE ON THE NORTH FORK OF THE AMERICAN RIVER.

View looking downstream from the north bank.

ACCOUNT OF THE INVESTIGATION OF DAMSITES AND IMPOUNDING COSTS.

It was anticipated that large dams at the sites first chosen would provide impounding capacity at low cost and enable mining to be developed on a scale that would be profitable. While surveys and calculations were in progress, further inspections of the gravels were made, to ascertain the gravel that would be worked and gold produced annually by mining behind these dams if impounding costs were favorable. In most cases a period of twenty years or more would be required to mine the gravel available with the existing water supplies and therefore costs were calculated for dams to provide capacity for twenty years work.

Choice of Dams.

Section 25 of the California Debris Commission Act directs that the recommendations already made concerning damsites shall be the basis for future work. Existing surveys were extended where necessary to gain additional impounding capacity. New surveys were also made.

Mr. A. L. Wisker, secretary-manager of the Nevada Irrigation District, supplied some engineering data on the Parker damsite on Bear River, and Mr. H. A. Kluegel, consulting engineer of San Francisco, cooperated by exchanging information on damsites on the North and Middle Forks of the American River. The capacities and preliminary estimates of cost given in this report are calculated by the Debris Commission engineer and in due course will be reported to Congress.

North Fork of the American River.

Three sites were considered. That at Owl Creek was favored because it will catch debris from Iowa Hill and from the north side of Forest Hill. That at Rice's Bridge on the road from Colfax to Iowa Hill was surveyed. This is a good dam site but would not catch Iowa Hill or Forest Hill material. Seven miles below Owl Creek is the North Fork site above the junction of the Middle Fork. This gives promise of lower costs than the other two sites. Each should be examined in detail. Preliminary estimates show costs of 2 cents or less per cubic yard of debris capacity. Calculations of impounding capacities were made as follows:

North Fork site—from private surveys.

Owl Creek site—from Debris Commission survey.

Rice's Bridge site—from surveys by the United States Geological Survey in cooperation with the State Water Commission, 1912.

Preliminary estimates of costs of dam construction were made as follows: North Fork site and Owl Creek site from private surveys, and Rice's Bridge site from the Debris Commission survey.

Middle Fork of the American River.

Calculations were made for a dam at Mammoth Bar or American Falls, utilizing for this purpose a survey made by the United States Geological Survey in cooperation with the State Water Commission, 1912, and a sketch map of the damsite made in 1890. A detail survey

will be required. There is another site that offers cheap storage on this river which should be examined in detail.

Bear River.

Three sites had already been surveyed, Van Giesens, Parkers, and Lower Bear River, the figures favoring a dam at the Lower Bear River site. This will catch debris from Bear River, Steep Hollow and the Greenhorn. The canyon at this point is favorable for concrete dam construction, the preliminary estimates indicating a cost under 1.5 cents per cubic yard of debris capacity. The water level would be raised above that of the Pacific Gas and Electric Company's Bear River diversion dam and canal, thus giving settled water at the intake. When this dam is filled, it could be raised or further storage obtained in a dam lower down the river at the Parker site. Rock conditions at the Parker site were reported as not so favorable for a concrete dam as at the Lower Bear River site. Parker site has been purchased by the Nevada Irrigation District and preliminary estimates indicate that debris storage there would cost from 2 to 2½ cents per cubic yard, measured at the mine.*

South Yuba River.

Two sites were surveyed, both having excellent rock bottom and sides. Operations on this stream will be larger than on any other, therefore, it was originally intended that one dam be constructed at Norton's Cañon and a second one twelve miles lower down at Jones Bar. This was proposed because of the large amount of gravel that it is expected will be worked. Unfortunately the preliminary estimates for both these dams gave high costs per cubic yard of impounding capacity from 2.8 to 3.8 cents, which is much too high for gravel estimated to yield 10 cents which is the value of the Bloomfield gravel.

Middle Yuba River.

Two sites were surveyed, Freeman's and Emory's Flat. Preliminary estimates for cost of storage at Freeman's were 1.9 cents. Near Emory's Flat there is a rocky canyon but the rock is strongly jointed and might give trouble in obtaining a water-tight foundation. The impounding cost there was much higher than at Freeman's.

The principal object of a dam on the Middle Yuba is to enable the low-grade gravels at North Columbia and Badger Hill to be worked. These are of great size and are estimated to yield 10 cents, and an impounding charge of 2 cents would prevent them from being mined at a profit.

Dam on the Main Yuba at the Narrows Site.

Both the Middle and South Yuba rivers would be served by a dam at the Narrows, also some gravel on the Main Yuba below the dam sites mentioned above, but a very large capacity would be needed to justify mining above this on a large scale because there is no site below the Narrows at which further impounding could be done.

*Telephone communication from Mr. A. L. Wisker, Jan. 25, 1927.

Fortunately a very large capacity is obtainable there. In addition there is great advantage because of the large flow of water, the flow of the Middle and South Yubas being increased by that of the North Yuba and the combined flow of the three will enable about 17,000 horsepower to be developed. Water may also be distributed to a large area of agricultural land from this point of vantage. Therefore, the purchase of debris capacity in a dam at the Narrows is the rational solution of the debris question for the South and Middle Yubas, for, by combining the three purposes of this dam it is possible to secure debris storage cheap enough to work low grade gravels. The proposal is embodied in the letter printed on page 35.

Space Left at End of 20 Years.

It will be noticed that the capacities of the dams recommended approximately equal the amount of debris expected to be produced in 20 years, except in the "Narrows" dam which would provide capacity for over 40 years at the estimated rate of work. In each case the debris impounding capacity is calculated with an allowance for debris lying in the cañon behind the lake of quiet water and rising at the rate of 15 feet to the mile. If the debris is retained in cañons at a different slope from this, the allowance may be changed, but in the meantime it is all that the engineers of the Debris Commission feel justified in making. When a fan-shaped deposit of debris forms at the head of a lake, the water coming down the slope will spread out over the surface and thereby lose much of its power of transporting debris. This will give a greater slope. A greater slope would very considerably augment the debris restraining capacity of each dam and lower the cost of impounding so that at the end of 20 years there may still be capacity for more debris and the water would be properly cleared before it overflows. This has been duly considered when adopting the allowance of a slope of 15 feet to the mile.

The yardage of debris that can be impounded by a dam would be the water impounding capacity plus the cubical contents of a prism bounded on the bottom by the plane of the water surface and on top by that of a surface graded back from the dam crest at a slope of 15 feet to the mile. The sides of the prism would be the sides of the cañon, and the contours of these were surveyed to enable calculations of this sort to be made.

SETTLEMENT BEHIND THE DAMS AND TURBIDITY OF THE OVERFLOW.

The settlement behind the dam and consequent relative clearness of overflow is a matter of strong interest because of the benefit to the river channels below, particularly the navigable channels. The flood flow in each stream was calculated by taking the highest flow recorded in Bulletin No. 5.*

Table III. shows that when the river reaches the headwaters of the lakes behind the dams, the velocity of flow will be reduced to such a low point that the load of debris will be dropped in the still water.

*Flow in California Streams, being Appendix A to Report to the Legislature of 1923 on the Water Resources of California (see Table 175).



Photo by Arthur Jarman.

THE "NARROWS" ON THE MAIN YUBA.

View looking upstream from the site of the proposed dam to be erected by the Yuba River Power Company. This will afford storage for 40 years of hydraulic mining on the South and Middle Forks and Main Yuba River. Approximately 17,000 horsepower can be developed here by a dam of the height proposed, 220 feet. This will impound 72,000 acre-feet of water.

Even the 'slickens' will settle because the velocities in the worst floods will only be from one-fifth to one-half foot per second.

The flow for the particular river branch was found by distributing the entire flood flow between the branches in proportion to the drainage area served by each.

At the position of maximum cross-sectional area of the lake impounded by the dam we shall have minimum velocity of current and therefore the best settlement.

Considering the flood flow passing this cross-section we obtain the velocity. It may be objected that the current does not distribute itself evenly and that there is greater velocity at the center of the channel than at the sides and bottom. The reply to this contention is that this flood flow velocity was applied to and used for times of average flow so that we have a large factor of safety. The velocities for minimum flow are not given. They would be very much lower.

At times of minimum flow the water normally in the river will be supplemented by that released from storage for use in the mines. It is at these times of small flow that turbidity will be at a maximum and not at flood time, the reason being that the proportion of debris to water will be at its highest. On some rivers there is only a small amount of unappropriated water left in the stream during the summer, and in all cases there are several summer months when 'piping' stops for lack of water. During these months the miners occupy themselves with the deepening of rock-cuts, extensions of tunnels, and driving drifts and cross-cuts for the placing of powder blasts to bring down the cemented gravel.

TABLE III.

Velocities of Water in Dams at Crest of Maximum Flood.

Dam	River	Flow in second-feet	Height of dam (feet)	Cross-sectional area in square feet	Velocity at crest of worst flood
Nortons.....	South Yuba.....	32,500	270	74,500	.38 feet per sec.
Jones Bar.....	South Yuba.....	32,500	220	61,300	.53
Freemans.....	Middle Yuba.....	20,000	225	170,000	.105
			125	57,200	.35
Owl Creek.....	North American.....	34,200	190	118,150	.29
Narrows.....	Main Yuba.....	111,000	220	600,000	.19
	Ordinary flood on Main Yuba.....	50,000	220	600,000	.09

The "Narrows" dam on the Main Yuba will restrain debris from large scale operations at Columbia Hill, Bloomfield and Omega, and it is important to notice that the velocity at times of worst flood recorded would be reduced to .19 foot per second at the widest portion of the lake. Ordinary floods for 29 years out of 30 do not exceed 50,000 second-feet flow and on these occasions the velocity would be reduced to .09 foot per second. Therefore settlement will be efficient even with operations proceeding on a large scale.

The Sacramento River at Sacramento at all times has a velocity 5 to 10 times greater than would be found in any of these dams and the turbidity found there results from that velocity.

Having calculated the flow in the dam lakes it is evident that any particles that remain in suspension would be so minute as to be microscopic and the water passing over the crest of the dam would be clear or at the worst only faintly cloudy. This clear water would benefit the navigable river channels by scouring them.

Fine sand that passes a 200 mesh sieve (having 40,000 apertures per square inch) settles readily at the low velocities given in this table. Any matter that remained in suspension would be fine colloidal material or clay that was worked with the gravel. This might discolor the water slightly but the sand and gravel that rolls down the rivers during winter rains would be permanently retained by the dams, thus benefiting the river channels below.



Photo by Ernest A. Bailey,
Flood Engineer, Sacramento.

DEPOT HILL MINE (Joubert's).

Operating on the North Fork of the Yuba River above the Bullard's Bar Dam.
March 4, 1926.

Prominence should be given to the fact that all surface soil and clay has been removed by former operations at Gold Run and Dutch Flat, also from much of the ground at You Bet and Little York, and for almost the whole of the enormous area available at Columbia Hill (or North Columbia). This very materially reduces the problem of settlement of mud from the water after use. After injunctions were obtained and mines were obliged to impound the debris caused by hydraulicking, further trouble was caused by the extreme turbidity of water and the **large amounts of actual debris in water that flowed from dams**; this eventually resulted in the tight shutdown of hydraulic mines. The miners were to blame in allowing debris to flow past the dams and **deliberately causing it so to do**. This is now a matter of history, but it explains the strong feelings of the farmers

and accounts for their employing agents or 'spies' to report such matters.

Since 1897 the Debris Commission has generally required dams to be of masonry or concrete construction in flowing streams to obviate failure and to prevent tampering with the structure. The success of such structures for the settlement of fine materials is seen at Bullards Bar on the North Yuba River. In April, 1926, when I visited this dam there had been good rains and a depth of nine-tenths of a foot of water was overflowing the crest from end to end (see Frontispiece), the total flow through the lake being 1700 second-feet, yet the water was so clear that not the slightest cloudiness could be detected by eye, i.e., the suspended matter was below one part in 10,000,000. Clays from natural denudation and from small hydraulic operations had settled completely.

THE RESTRAINING OF NATURAL DEBRIS AND VALUE FOR FLOOD CONTROL.

Mr. Ernest A. Bailey, engineer for Flood Control, Sacramento, has taken great interest in the relations of this hydraulic work to that of flood control in the Sacramento Valley, and I have had the pleasure of visiting most of the flood control works in his company. These flood control works represent a considerable capital expenditure and it is well to emphasize the fact that the clear water from the proposed dams will increase the scour of the river channels and in this way assist in reducing the flood menace in the Sacramento Valley.

Rivers flowing through mountain districts have steep gradients and therefore a high carrying power. They have beautifully clear water in the summer months of small flow because the winter freshets have carried away all the light material that causes turbidity. In winter they have heavy loads of sand and gravel and are turbid with clay and soil washed from the hillsides. This material is carried down to the quiet stretches of river where most of it is deposited and is later removed by dredging. The finest particles remain in suspension and pass down to the harbor.

Very little data is available on the subject of turbidity of the rivers mentioned in this report. A few samples were taken from the surface of these streams and they showed considerable sand during winter months. Gravel also rolls down the bed of the stream but this can not very well be measured. It is known to move downstream during winter floods because pools become cleared from gravel that is dumped into them. Debris dams will prevent this natural debris from travelling downstream and will thereby benefit the channels below. The clear water that overflows the dams will assist by scouring the channels of the rivers below, and in this way materially assist in reducing the danger from floods. The dams proposed are not large enough to be used for flood control, but the combined effect of storage of water for use above the mines and restorage below them in the debris dams will operate in the direction of reducing the peaks of floods.

Sediment in Some Samples from Rivers Dealt With in This Report.

River	Locality	Date	Sediment in parts per 1,000,000 by weight	State of the river
South Yuba-----	Edward's Bridge-----	Apr. 9, 1926	103	Fine weather and good flow of clear water
South Yuba-----	Washington-----	Jan. 2, 1927	1,560	Raising river, freshet, water very turbid.
Wolf Creek-----	Above Junction-----	Apr. 8, 1926	238	Creek in flood—raining.
Bear River-----	Gautier Bridge-----	Apr. 8, 1926	1,080	Big Flood—raining.
Willow Creek-----	Garden Valley-----	July 2, 1926	510	
Pine Grove-----	Jacksons-----	Mar. 10, 1926	90	
Sacramento-----	S. P. Bridge-----	Apr. 10, 1926	32	High water, flood subsiding on American River, but at its highest on the Feather.
Sacramento-----	S. P. Bridge-----	Dec. 10, 1926	96	High water, a few days after the levees were in danger at Colusa.
North Yuba-----	Bullards Bar Dam---	Apr. 2, 1926	less than .1	Perfectly clear; not even a faint cloudiness; 1700 second-feet or 68,000 miner's inches overflowing the crest of the dam.

THE POWER DEVELOPABLE.

Calculations were made based on the figures for drainage area and seasonal run-off and distribution of run-off as given in Bulletin No. 5, 'Flow in California Streams,' by Paul Bailey. The results are only approximate because water is drawn off by various ditches and some of it is not returned to the stream. Daily gaugings would be needed for a long period to determine the water power available at each dam site. Nevertheless the figures obtained indicate what may be done in this way.

Provision should be made at each dam for the utilization of water power and to enable stored water to be drawn off to assist in irrigation in times of low water.

Use of Stored Water.

In dry months when the hydraulic mines have stopped piping, the water behind each dam would be valuable to farmers in country below. At these times the water may be released without affecting the work of the mines and any revenue derived therefrom would accrue to the state.

North Fork of the American River.

For four months the flow is below 3.6 per centum of the total and for three months it is less than 1 per centum. Assuming 150 feet of fall at the proposed dam, the average year will give 600 horsepower for twelve months without drawing on storage and 1200 horsepower for nine months. In the driest year recorded it would give 1200 horsepower for eight months using a dam of the size contemplated.

Middle Fork of the American River.

This dam would only give a fall of 45 feet and the fall would give 360 horsepower for the whole of the average year and 1000 horsepower for nine months. In the driest year recorded it would give 650 horsepower for more than eight months.

Lower Bear River Dam Site.

A dam with a crest 143 feet above low water would benefit the Pacific Gas and Electric Company's Bear River Canal leading to the

Halsey Power House by submerging a portion of it and supplying water free from sediment, at the same time allowing water to be drawn from storage in dry months. It would not have value as a power producer, because almost all the water is used already for this purpose being drawn off by the above mentioned canal.

Conclusion.

The value of the power developable at these dams is small because the dams are small and do not give enough fall, nor do they give enough water storage for running in dry months. It is probable that larger dams on the North Fork and Middle Fork of the American River would develop power that would pay and if so, the lower portion of the dam would serve to impound debris without detriment to the power feature of the plan. This would give opportunity for cheaper storage. Private investigations of the possibilities of power development have not proceeded far enough to enable negotiations for debris storage to be considered. Hydraulic mining and the development of power are not antagonistic. One is supplemental and helpful to the other and the development of a water storage system to give considerable pressure head for 'piping' naturally leads to this system being used for hydroelectric purposes when mining ceases. The stoppage of hydraulic mining led to the transfer of many of the water systems to power companies.*

If hydraulic mines are revived by the provision of storage dams they will renovate and enlarge their water systems which at the close of all mining will naturally become useful for hydroelectric power production and irrigation. In the latter cases the charges for service are subject to strict regulation by the State Railroad Commission as such concerns are regarded as public servants. Hence, after mining ceases, the farming and general community will continue to benefit from the additional water supplies developed by mining.

As work progresses on the large gravel deposits at Gold Run and at Columbia Hill, it will be possible in each case to leave a hydraulic pit in such a position that it will have great value for water storage and power development. As the gravel approaches exhaustion and

*The power business in California had its beginning in the mining business. Miners pioneered the path of the hydroelectric engineers of today. Their methods of construction, the manner in which they moved heavy machinery and material into rocky, remote regions, their designs for flumes, dams, and ditches, their tangential water wheel, all left a lesson to be learned, and as the hydroelectric engineers of the new day read the record in the rocks the achievements of the sturdy men of the mountains took hold of them and inspired the vision that brought about the wonderful developments of the power industry that have made California the envy of the world. None know the story better than the P. G. & E. This company supplied more power to gold mines than all other companies in the State combined. Never an engineer goes over its system but he realizes its debt to the old miners. Ten of the company's twenty-eight water power plants were originally initiated to provide energy for mining operations. Nine of its plants were installed on canals dug to supply water for mines. Out of that same hunt for gold came ten of the company's reservoirs. Blindly, perhaps, but like a Titan, the old-time miner builded for the future. Tonight his reservoirs, feeding power plants on some Sierra slope, will light homes hundreds of miles away. Some of his canals, blasted out of the rocks in the old pack-train days of the '50's, still wind their rugged way through twenty miles and more of mountain in the great wheels that in a twinkling create the spark that spins a thousand factory wheels and makes goods, and work for multitudes, and cargoes for ships, and payrolls, and prosperity. It is a stirring tale, a tale too long to be told in a breath. It is a book, a book not yet written and too vast a work for the modest chronicler. The miner made California, and it is still his state, for the age of electricity has but sealed his title.—*California's Debt to the Miner, P. G. & E. Progress, Vol. I, No. 8, p. 2, July, 1924.*

the water power value increases, the latter may become a better source of revenue than mining for gold. On the other hand the lack of new discoveries of large gold fields and the increasing use and actual destructive consumption of gold in the arts makes this unlikely for many years. It is more probable that the purchasing power of gold will increase owing to its scarcity than decrease owing to the utilization of paper instead of coins. The use of paper for currency has probably reached its maximum.

RELATION OF THIS PLAN TO THE PROPOSED STATE PLAN OF WATER CONSERVATION.

State Engineer Paul Bailey called attention to the comprehensive scheme that his department is evolving to conserve and utilize to the best advantage the waters of the state. Several bulletins* of valuable information have already been published in connection with that inquiry.

If the water conservation plan is adopted by the state, enormous reservoirs would be constructed which would be able to accommodate the expected volume of hydraulic mining debris without its occupying more than 5 to 10 per centum of the water capacity of the reservoirs that are proposed. Two of these damsites are marked on the map, viz: those at Folsom and at the 'Narrows.'

It is to be hoped that this comprehensive plan for conserving the waters of the state will be adopted, or some modification of it, but the expenditure is large, and it may have to wait a time of education and campaigning before such expenditure will be sanctioned. In the meantime hydraulic debris dams can be built for a relatively small sum of money. These dams would supplement those proposed for water conservation and would in no way conflict with them.

*Bulletins Nos. 5, 6, 7, 8, 9 and 12.

GROWTH AND DECLINE OF HYDRAULIC MINING.

Hydraulic mining as defined by the state and federal acts "is mining by the means of the application of water, under pressure, through a nozzle, against a natural bank, thus eroding the bank." The mixture of gravel, sand, loam and water runs along rockcuts and sluices that eventually discharge on lower ground leading to streams that carry the material away. The sluices contain riffles to retain the gold that settles in them. Quicksilver is generally placed in the riffles to assist in catching the finer particles of gold.

This method of mining was invented in California in 1853. The first rigs conducted water from the ditch to the face of the gravel bank by wooden boxing and canvas hose. These were soon replaced by iron pipes which withstood considerable pressure, and after this improvement the gold obtained grew by leaps and bounds until the state became world famous for this class of mining. The scale of work reached enormous dimensions, the gravel washed by this process in 1880 being estimated as 46,025,391 cubic yards, which is equivalent to a piece of ground one mile long, one mile wide and 15 yards deep. All this was washed into the rivers in twelve months. No wonder the hydraulic miner soon had trouble on his hands. Such an enormous scale of hydraulicking has never been approached in any other country.*

Mr. Waldemar Lindgren, in his classical memoir on the Gravels of California¹ reviewed the estimate made by Gilbert² and by the State Engineer and by engineers of the Debris Commission, and he concluded (p. 21) that the nearest approach to a measure of the gravels that had been washed into tributaries of the Sacramento River alone was 1,295,000,000 cubic yards. Most of this was washed prior to injunctions such as the famous decision by Judge Sawyer in 1884. The rate of work quoted for the year 1880 was estimated in a report presented to Congress in 1882, by Lieut. Col. G. H. Mendell.³

The water used in the Sacramento Basin was obtained from the returns of the county assessors, and this information was supplemented by further information from the State Engineer's Department. Knowing the water used and having some estimates of the amount of work that could be done by a 'miner's inch' of water as determined by surveys and measurements, it was calculated that the total yardage moved in the Sacramento Basin in 1880 was 38,610,926 cubic yards. Similar information concerning rivers south of the American gave a total of 7,414,465 cubic yards, so that the total for the northern half of the Grand Valley was 46,025,391 cubic yards.

* For a more detailed history of this trouble and its consequences, see pages 146 to 152 of a report entitled SACRAMENTO FLOOD CONTROL PROJECT, revised plans submitted to the Reclamation Board by W. F. McClure, State Engineer, February 10, 1925, (issued 1927).

¹The Tertiary Gravels of the Sierra Nevada of California, by Waldemar Lindgren, being professional paper No. 73 of the United States Geological Survey.

²Hydraulic Mining Debris in the Sierra Nevadas, by Grove Karl Gilbert, being professional paper No. 105 of the United States Geological Survey.

³Mining Debris in California Rivers, Ex. Doc. No. 98, 47th Congress, 1st session.

This is shown in the following table which is compiled from tables given in Lieut. Col. Mendell's report (pp. 15 and 16) :

River	Water used, miner-inch-days	Duty, cubic yards per M.I.D.	Gravel moved cubic yards
Table Mountain or Dry Creek.....	833,250	3½	2,916,375
Butte Creek.....	24,000	3	84,000
Feather River.....	1,259,363	3½	4,407,770
Yuba River.....	5,458,171	3½	19,103,598
Bear River.....	1,117,082	3	3,351,246
Dry Creek No. 2.....	44,229	3	132,687
American River.....	1,914,500	4½	8,615,250
Totals.....	10,650,595	-----	38,610,926
Rivers south of the American.....	3,384,370	-----	7,411,465
Grand totals.....	14,034,965	-----	46,025,391

The deposits on the Feather River are dispersed over a large area, but those on the Yuba, Bear and American rivers are closer together, making a district that was one of considerable activity. All the material in the upper part of the table was eventually discharged into the Sacramento River and its tributaries above the capital city.

The immense scale of these operations caused serious silting of the river channels and partial blockage of streams tributary to them, so that in flood times much damage was done to farm lands adjacent to the rivers. In consequence there were many actions at law in the state courts which resulted in injunctions against the mines. Immediately prior to the general closing of hydraulic mining the annual yield is estimated to have been reduced to \$5,300,000.¹

Finally the decree of Judge Sawyer of the United States Circuit Court restrained the North Bloomfield Mining Company from discharging debris into the streams. This was in 1884. The court reserved the power to modify or suspend the injunction upon the defendant's showing that conditions had been so changed that the discharge of debris may be conducted so as not to continue the nuisance complained of. That is to say, hydraulic mining was not declared to be illegal, but the discharge of debris into the streams was forbidden. The provision of a dam to restrain the debris might make the necessary change in conditions to allow mining to be resumed.

Mine after mine was closed by injunction based upon this decision, and the federal legislation passed in 1893 (the California Debris Commission Act, or Caminetti Act) embodied the principles declared by these injunctions, but enacted more severe penalties for their non-observance.

Present State of the Law.

The present state of the law is that hydraulic mining is illegal if carried on in such manner that it injures the navigable river channels of the Sacramento or San Joaquin river systems or the lands adjacent thereto; that the efficiency of a dam for restraining debris so that it

¹See Chas. S. Haley, "The Gold Placers of California." Bulletin No. 92, California State Mining Bureau, 1923, p. 16.

shall not reach these channels is subject to approval by the Debris Commission, and a permit from that body is necessary before mining may be started.

Gold Production and the Effects of Litigation and Legislation.

How much gold was obtained from hydraulic operations is not known, as the statistics that are available do not segregate the gold according to origin or method of production until the year 1897. Much gold was never reported and considerable sums may have been exported without being included in returns given by the mints, smelters, or express companies, to whom we are indebted for the only statistics of early years that are available.*

Lieut. Col. Mendell in his report of 1882 (Ex. Doc. 98) already quoted, gives a very complete account (pp. 22, 23) of all data that was available, and shows that from 1848 to December, 1881, the value of the known total production of gold from all sources in California was \$1,178,000,000. Mr. Waldemar Lindgren in Professional Paper No. 73, already quoted, states (p. 81) that the production up to the end of 1909 amounted to between \$1,200,000,000 and \$1,500,000,000.

Of this amount he considers that one-fifth came from quartz veins and the bulk of the remainder was from river gravels that were very rich and easily washed. The gravels that were higher in elevation and required hydraulic methods to treat them, and which geologists speak of as the tertiary gravels, he considers produced up to the end of 1909 about \$300,000,000. A reliable estimate cannot be made for lack of data, and Mr. Lindgren calls this figure of his a "conservative guess." The gold production from all sources for 1880 (including the silver value that it contained) was \$18,276,166,¹ according to Mendell's report.

Prof. J. D. Whitney in his *Auriferous Gravels*, written in 1879, says (p. 368): "The best authorities estimate the present yield from this source (hydraulic) at from \$12,000,000 to \$14,000,000,"² (per annum).

The Miners' Association estimated in 1881 that the annual gold production from hydraulic mining was between \$11,000,000 and \$13,000,000.

John Hays Hammond, writing in the IX Annual Report of the California State Mineralogist, 1899, said (p. 121): "The recent suppression of hydraulic mining by judicial decisions has reduced the annual gold product of California by at least \$10,000,000 * * *"

The rapid fall in production from hydraulic mining after injunctions began to be issued has already been mentioned, and the present production averages only \$122,114 (see p. 12).

* Years ago Wells, Fargo & Co. offered to the Mineral Resources Division of the U. S. Geological Survey all the receipts for gold bullion shipped through their agency from the beginning of gold mining in California. To work upon this mass of paper and produce therefrom a statement of yields from the individual mines would have required a staff of clerks for some months. Neither the Geological Survey nor the State Mineralogist office had funds to do this work and no prospect of obtaining funds for it. The papers were burned to get rid of them and thus perished much valuable data on the gold production of mines in California.

¹Estimated by J. J. Valentine, Supt. Wells, Fargo & Co., see Mendell's Report, p. 23.

²*Auriferous Gravels of the Sierras. Memoirs of the Museum of Comparative Zoology of Harvard; Contributions to American Geology, Vol. I, by J. D. Whitney.*

Benefits That Were Intended for the Hydraulic Miner in the California Debris Commission Act.

The California Debris Commission Act was passed not only to protect farming lands and navigable rivers, but was also intended to assist hydraulic mining. The miners expected it to accomplish great things for them. It provided a nonpolitical body of army engineers whose duty it is to administer the act, survey the rivers for dam sites, erect dams when money was appropriated for them, and study and research "in devising a method or methods whereby such mining may be carried on as aforesaid" (Sec. 5).

To quote section 25 of this act in part:

"Sec. 25. That said commission * * * is hereby directed and empowered, when appropriations are made therefor by law * * * to build at such points above the head of navigation * * * such restraining or impounding dams and settling reservoirs * * *."

The act further provides the rate of payment that shall be made for mining behind such restraining dams, the determination being made in a very simple and direct manner and at low cost to the miner. To quote section 23 in part:

"Sec. 23. * * * the individual, company or corporation operating thereunder working any mine or mines by hydraulic process, the debris from which flows into or is in whole or in part restrained by such dams or other works erected by said commission, shall pay a tax of three per centum on the gross proceeds of his, their, or its mine so worked; * * *"

RESULT OF THE PRESENT INQUIRY.

Gravel Deposits That May Be Benefited.

Although no dams have been built by the Debris Commission as forecasted by this act, and although the production for 1925 was only \$175,345 of which less than one-half was from the Grand Valley, there are some remarkably fine gravels that await the solution of the present difficulty—the provision of efficient debris impounding capacity at low cost.

In a report made to congress by the United States Corps of Engineers in 1891 (Ex. Doc. 267, p. 86) the gravel remaining in the Sacramento Basin and workable under the old conditions (*i.e.*, without restrictions as to dumping the debris) was estimated as 518,725,000 cubic yards; and a much larger amount if long tunnels and ditches were constructed to give access to ground not yet available—viz: 1,508,875,000 cubic yards, which is more than the amount already washed.

The restraining works at Daguerre Point were completed in 1910 but no moneys have been appropriated to enable the commission to build dams for the hydraulic miner. The matter has lain in abeyance in spite of official reports that such huge quantities of gravel are available, therefore this report deals only with those rivers where work formerly proceeded on the largest scale, and where water supplies are still available, viz: the Middle and South Yubas, Bear River, and the North and Middle American, all of which eventually discharge into the Sacramento River above Sacramento City. (See the map which accompanies this report and shows the locations of the gravels and of the various dams proposed.)

The most important reports already made to congress are Lieutenant-Colonel G. H. Mendell's reports of 1881 and 1882,* also the report of the Board of Engineers, made in 1891.**

The first two deal with conditions two or three years before injunctions were issued, and the last one reports conditions as they were six years afterwards. With these as a starting point the gravels have been visited, and conditions that affect them have been reviewed.

Preliminary investigations raised the hope that by utilizing these vitalizing provisions of the act, that is, by providing dams, hydraulic mining might be revived on the Yuba, Bear, and American rivers to an industry of considerable size.

Inspection of the more important gravels in these districts for the present Hydraulic Mining Commission showed that only 712,000,000 cubic yards could be regarded as workable under the changed conditions. A preliminary estimate of this amount was communicated to the California Debris Commission, February 15, 1926, and was as follows:

**Preliminary Memorandum of Workable Hydraulic Gravels
February 15, 1926, According to River Basins.**

	<i>Millions of cubic yards</i>
North Fork American:	
Iowa Hill, Gold Run, Yankee Jim.....	115
Above Rice's Br. and N. Fork Br.	
Middle Fork American:	
Forest Hill, Michigan Bluff and Todd's Valley.....	30
Above Ruckachucky Canon.	
Bear River, with Greenhorn and Steep Hollow:	
Liberty Hill and Dutch Flat, Little York,	
Yon Bet, Red Dog, Chalk Bluff, Hunts Hill.....	43
Above Van Giesens and below Greenhorn Ck.	
South Yuba:	
Alpha, Omega, Sailor Flat, Blue Tent, Relief Hill.	
Above Edwards Br.	
N. Bloomfield, Malakoff, Lake City, N. Columbia,	
Esperence, Fr. Corral.....	415
Above Edwards Br. or Jones Ravine.	
Catch fines at Narrows.	
Middle Yuba:	
N. San Juan, Birchville, Badger Hill, Cherokee, Moores	
Flat	109
Above Emory Ford, Freemans Br. & Narrows.	
Total	712

This is a preliminary statement of gravel in place which can be handled by hydraulic mining, having sufficient grade and not being capped heavily by volcanic material.

ARTHUR JARMAN.

February 15, 1926.

For Mr. Egenhoff, California Debris Commission.

To mine this gravel it was recommended that dams would be required on the Middle and South Yubas, the Bear, and the Middle and North American rivers, in positions to be chosen from those shown on the accompanying map. Data on some of these sites were already available and the California Debris Commission sent their

*Known as Ex. Doc. No. 76, 46th Congress, 3rd Session, 1881, and Ex. Doc. No. 98, 47th Congress, 1st Session, 1882.

**Known as Ex. Doc. No. 267, 51st Congress, 2nd Session, by Lieut. Col. W. H. H. Benyaard, Major, Thos. H. Handbury, and Major H. H. Heuer.

survey parties in the field to survey others. The results of this work have already been recorded.

Estimation of Probable Rate of Working.

Totals for 20 years are given in Table I compiled from the estimated rate of working of the principal gravels on each river, the data being given at the end of the report for each river in turn. The yardage workable at each mine is calculated from the water available. Any increase in water supplies would increase the production beyond that given in the tables.

The rate at which gravel can be mined depends chiefly upon volume of water that can be run over the broken bank of gravel to carry it into the rockcuts and along the sluiceboxes. Good grade in rockcuts and sluiceboxes is more important for output than pressure at the nozzle, because it is the amount of material that can be transported out of the pit and down the sluiceboxes that actually determines the volume that can be mined. A bank of gravel can be broken down more rapidly than the gravel can be washed down the sluiceboxes. Cemented gravel can be shaken to pieces by the judicious use of powder when breaking down the bank, and moderate water pressure will give sufficient impetus to the jets to carry gravel into the cuts.

Justification of a Dam for Each River in Turn.

Considering each river separately we have at least one large gravel deposit which if proven to be profitable under the proposed conditions of resuscitation would by itself justify the erection of a dam so large that it would also serve other mines on that river. Judged in this way we may say that a dam that would serve the principal deposit for 20 years would serve all deposits on that river for 15 years, or something of this order, each case having to be worked out according to the deposits and the conditions.

This method of treatment has been followed, the 'key' deposit on each river receiving most attention. It has been impossible to obtain data required for the smaller mines or portions of gravels to enable reasonably close estimates to be made, but approximate yardages were calculated for ground favorably situated so that no mechanical difficulties would prevent it from being worked. The ground considered to be payable has been restricted to ground that would be readily worked.

(COPY)

THE YUBA RIVER POWER COMPANY

725 Standard Oil Building, San Francisco, California.

January 29, 1927.

Hydraulic Mining Commission,
Ferry Building,
San Francisco, California.

Attention Mr. Arthur Jarman, Secretary.

Gentlemen :

The Yuba River Power Company is the owner of a comprehensive project for the development of the water resources of the Yuba River in the joint interests of the power, agricultural and hydraulic mining industries. This project comprises a series of power plants and reservoirs along the Yuba River and its North and Middle forks. The Bullards Bar unit was the first unit contracted under this project. The Yuba River Power Company has purchased certain lands for its various units, and the Federal Government has withdrawn in aid of the project the Federal lands necessary. This company also has applications before the Federal Power Commission and the Division of Water Rights of the State of California for the water and power rights pertaining to the additional units in the complete project.

Your Commission is interested in that phase of our development program covering the storage of debris from the operation of hydraulic mines. The construction of the Bullards Bar Dam has provided storage space for debris on the watershed of the North Fork of the Yuba River. Therefore, so far as the Yuba is concerned, it is now necessary to deal only with the South and Middle forks. This problem can be solved by the construction of The Yuba River Power Company's unit at the Narrows, near Smartsville, on the main river.

At present, our preliminary cost estimates on the Narrows unit have been made without actually drilling the dam site, nor have final figures been worked out as to revenues from power and irrigation and debris storage space, but preliminary estimates indicate that we can sell outright the 350,000,000 cubic yards of debris storage space for \$1,500,000. This quantity is the actual cubical contents of debris storage space estimated to be available at the Narrows unit with a dam having its crest at elevation 520 feet above mean sea level.

In the meanwhile we will place at the disposal of the Hydraulic Mining Commission and the California Debris Commission, all data which is in our possession, and cooperate in every way and offer all facilities for such further investigation of this subject as are considered necessary. We consider it only fair that in return, any engineering data required by either of the Commissions should be made available to all parties concerned.

Very truly yours,

THE YUBA RIVER POWER COMPANY.

(Signed) By R. E. PHELAN, President.

R.E.P:R.

Copy to California Debris Commission.

Address Reply to
Secretary, California
Debris Commission,
85 Second St.

(COPY)

WAR DEPARTMENT

California Debris Commission,
San Francisco, California.

Refer to File No. 26761.

Subject: Preliminary estimates of proposed debris dams.

Mr. Lloyd L. Root,
State Mineralogist,
Ferry Building,
San Francisco, Calif.

Dear Sir:

Inclosed please find statement you have requested for the information of the
California Hydraulic Mining Commission.

FOR THE CALIFORNIA DEBRIS COMMISSION:

Very truly yours,

(Signed) C. S. RIDLEY,
Major, Corps of Engineers.
Member and Secretary.

1 Incl.
(statement)

Estimates.

Following are preliminary estimates made up from data available at this time. The storage estimates are based on those considered necessary or desirable for 20 and 10 year periods of mining operations respectively and the assumption is made that the debris will stand on an average slope of 15 feet to the mile.

Twenty Year Period.

<i>River</i>	<i>Site</i>	<i>Storage, cu. yds.</i>	<i>Cost</i>
Middle Yuba-----	Freemans -----	51,000,000	\$1,150,000
South Yuba-----	Nortons -----	70,000,000	3,090,000
South Yuba-----	Jones Bar -----	20,000,000	745,000
Bear-----	Lower Bear -----	21,000,000	310,000
North Fork American-----	Owl Creek -----	41,000,000	935,000
Middle Fork American-----	Mammoth Bar -----	22,000,000	125,000
Totals-----		225,000,000	\$6,355,000

Ten Year Period.

<i>River</i>	<i>Site</i>	<i>Storage, cu. yds.</i>	<i>Cost</i>
Middle Yuba-----	Freemans -----	26,000,000	\$545,000
South Yuba-----	Nortons -----	35,000,000	1,450,000
South Yuba-----	Jones Bar -----	13,000,000	420,000
Bear-----	Lower Bear -----	11,000,000	195,000
North Fork American-----	Owl Creek -----	21,000,000	470,000
Middle Fork American-----	Mammoth Bar -----	11,000,000	100,000
Totals -----		117,000,000	\$3,180,000

The estimates for Freemans, Nortons, and Jones Bar sites are based on surveys made under direction of the California Debris Commission during the past year and are complete except that no subsurface exploration has been made of the dam sites. The estimate for the Lower Bear site is based on a combination of three surveys: One by U. S. Geological Survey in cooperation with the State of California, one by the California Debris Commission in 1905, and one by the California Debris Commission in 1924-25. It is believed to be reasonably close for preliminary estimates, but if construction work is contemplated, further check surveys should be made. No subsurface exploration was made at the dam site. The estimates for the Owl Creek site are based so far as the reservoir is concerned on data collected during the past year under the direction of the California Debris Commission. The reservoir site was taken from a private survey. No subsurface exploration was made at the dam site. The estimates for the Mammoth Bar site are based on two surveys: One of the area covered by the reservoir made in 1912 by the U. S. Geological Survey in cooperation with the California State Water Commission and published on a scale of 2 inches equals 1 mile; and the other of the reservoir site on a sketch map made under direction of Major W. H. Heuer. The nature of these data of course makes the above estimate of cost for this site only a rough approximation and if construction work is contemplated additional surveys are necessary. No subsurface exploration has been made at the dam site.

It will be noted therefore that borings are required at all of the dam sites before final estimates can be made or indeed before final decision can be made as to the practicability of dam construction at these sites. In addition to this further surveys are needed at the Lower Bear and Mammoth Bar sites.

GRAVELS OF THE NORTH FORK OF AMERICAN RIVER.
Estimates of Gravels on North Fork of American River—Quantities in
Millions of Cubic Yards.

Name of report.....	Whitney	Mendell	Board of Engineers	U. S. G. S.	This report
Engineer.....	(Pettee)	(Larson) Ex. Doc. No. 98	(Turner) Ex. Doc. No. 267	(Lindgren) Prof. Paper 73	(Jarman)
Year made.....	1879	1881	1891	1911	1926
Gold Run.....	86 to 125	<div>18.48 1.21 on 95 acres only</div>	<div>46.0 on 555 acres</div>	92	75
Iowa Hill—proper.....	23 to 24	6.38	28.7 to 30.0	-----	8
Bird's Flat.....		7.26		-----	
Momona Flat.....		4.06		-----	
Roach Hill and Independence Hill.....		1.62		-----	
Wisconsin Hill.....	-----	5.08	-----	-----	Over 12
Gleason.....	-----	-----	-----	-----	
Big Dipper.....	-----	-----	-----	-----	
Forest Hill—North Side.....	No estimate	19.36	-----	No estimate	* 10 claimed
Mayflower.....			12.0	No estimate	
Smith's Point.....			5.8	No estimate	
Georgia Hill.....			0.5	No estimate	
Lost Camp (Blue Canon).....			-----	-----	
Totals.....	109 to 149	63.45	93.0 to 94.3	-----	Over 95

*Doubtful whether this would be worked.

Rate of Work Expected on North Fork of the American River and Production
for First Twenty Years.

Mine or district	M.I.D. available	Duty	Per annum		For first twenty years	
			Yardage	Yield	Yardage	Yield
Iowa Hill.....	150,000	4	600,000	\$42,000	12,000,000	\$840,000
Gleason.....		2	500,000	70,000 to 95,000	10,000,000	1,650,000
Big Dipper.....						
Gold Run.....	250,000	-----	Doubtful	if these would be worked	-----	-----
Forest Hill.....	*	-----	50,000	7,500	1,000,000	150,000
Lost Camp Mine at Blue Canon.....		-----	-----	-----	-----	-----
Park and Brown Mine.....		-----	-----	-----	-----	-----
Totals.....	400,000	-----	1,150,000	\$119,500 to \$144,500	23,000,000	\$2,640,000
Average per annum.....	-----	-----	-----	\$132,000	-----	-----

*Purchased, quantity variable.

In 1880 the total water used on the three forks of the American River was 1,914,500 M.I.D., with a duty of 4½; this gave an annual yardage of 8,615,200. The duty would be lower than 4½ because the gravel at Gold Run is middle and bottom gravel, all top stuff having been removed

GOLD RUN.

North Fork of the American River.

The Gold Run gravels are the key to the case for the North American River. The deposit extends from Indiana Hill on the south to Dutch Flat on the north, a distance of four miles. The width of the gravel varies from 600 to 1000 yards and averages over one-half mile. More than half of this ground is on the south side of the ridge along which runs the railroad. Most of this is under one ownership, having been consolidated in 1911, and would be economically worked in consequence. It is on the south or American River side of the ridge that separates the North Fork American from the Bear River. The length of channel is 4053 yards; this has an area of 1,401,180 square yards



Photo by Ernest A. Bailey,
Flood Engineer, Sacramento.

STEWART GRAVEL MINE AT GOLD RUN.

View looking north, showing the pit of the mine with the slate bedrock exposed and the rock cuts in it. The extension of this pit by future hydraulic work will create a reservoir useful for water conservation and the development of power. Debris will be restrained by a dam on the North Fork of American River.

leaving out of account gravel too far to one side or too high on rims to be worth while attacking.

Starting at the south end of this ground, at Indiana Hill, the bedrock has been washed clean for about 330 yards along the channel, then there is a body of bottom gravel 40 to 60 yards deep occupying the channel for 220 yards this has been tunneled and drifted. Immediately north of this gravel is the old Indiana Hill pit; the bedrock here was washed clean for 550 yards along the channel and for a width of 700 yards. In both pits the bedrock slate is very gently dished, being the floor of a glacier. Banks of gravel were left on the sides

or rims of this channel and under them the rock rises sharply. At the north end of Indiana Hill pit the gravel has been drifted; the main tunnel was driven 553 yards along the channel, most of it at a few feet above bedrock. This makes 1633 yards of channel explored by drifting or exposed by hydraulicking.

Up to this place on the channel the amount of gravel is calculable and is 27,436,000 cubic yards, the depth of gravel being known from surface survey and from the known bedrock positions. It is 2420 yards from this point to the railroad or north end; the gravel surface is known but bedrock is not exposed again until Dutch Flat is reached, when it is found to have risen about 100 feet in 4 miles of channel. There are no surface indications of faulting. This section of gravel therefore has bedrock with a grade of about 25 feet per mile and similar to that exposed by workings in the south end as already described. As the gravel is wider here, it is expected that the bedrock will be flatter than before, as is usual in these gravels of the Sierra. Knowing the elevation of the gravel surface and deducing the position of the bedrock in this manner, we have depths of gravel in the center of the channel from 66 to 80 yards.*

As these depths are applied to calculate the yardage for a considerable length of channel (2420 yards) and an area of 895,400 square yards, I have assumed as a factor of safety that the bedrock is dished or curved instead of almost flat.

If the bedrock were horizontal right across, the cross-section would be rectangular and we should have 62,672,000 cubic yards but with the channel of curved cross-section we obtain about 47,500,000. Add this to our previous figure of 27,436,000 and we have the total of approximately 75,000,000 cubic yards as the gravel available and workable if gold contents are satisfactory.

The Table on page 41 gives other estimates for the purpose of comparison.

Values in the Gold Run Gravels.

In the absence of sampling by prospecting shafts or other openings in the unworked gravels, it is necessary to use what past records are available. Unfortunately these are only of a fragmentary nature due to the fact that Mr. Jas. D. Stewart's library and papers were burned when his residence was destroyed by fire at Auburn, in 1916.

The top gravel washed in early times has gone, being washed off along the whole length of the channel except for the narrow strip under the railroad and highway, and some rim gravel out on the sides, that is not included in this estimate.

The old accounts of this top gravel must be considered as they are apt to be quoted, though they do not represent the deeper gravel that remains.

Whitney, p. 147, records the following estimate made by W. H. Pettee in 1879. Between the railway and the southern end an area of 427 acres had been worked and his measurements showed 43,000,000 cubic yards were washed off. Returns from the banking house of Messrs. Moore and Miner at Gold Run, from March, 1865, to October, 1870, showed bullion shipped \$1,385,280.55. Much gold was known

*These depths were ascertained by Mr. J. D. Stewart by surveys.

to be shipped by other routes and he assumed \$615,000 of gold sold elsewhere, giving a total of \$2,000,000 approximately, which gives a value of 4.65 cents per cubic yard. This was mostly top gravel.

He remarks that this amount of gold per cubic yard falls much below the estimates of miners and claim owners.

E. Call Brown, consulting engineer of Los Angeles, reports that between 1856 and 1882, five properties in this district bought an aggregate of 10,000 miner's inches of water per day at 50 cents per 24-hour inch*

Ross E. Brown,** in 1867 reports that these mines paid \$1,000 per day for 9000 miner's inches (or 11 cents per miner's inch). Raymond, in the same series, 1875, p. 102, says the water rates in this district are $12\frac{1}{2}$ cents per inch per 24 hours. It does not seem likely that old time miners were washing 5-cent gravel with such expensive water, even though the surface gravel at Gold Run had the reputation of being very easy to wash.

Waldemar Lindgren (Prof. Paper No. 73, p. 45) says "the yield per cubic yard of hydraulic gravel is said to be 11 cents." Lindgren is cautious in all his statements, and though he gives this value in a tentative manner, he does not even mention the lower figures given by Pettee. It may be that this gravel, very close to surface, was low in value, as at Bloomfield and Columbia Hill or North Columbia. Lindgren says 84,000,000*** cubic yards had been washed away. This is 41,000,000 more than Pettee's estimate, so that the gravel then being washed would be deeper and richer.

Mr. Jas. D. Stewart worked at Gold Run as a youth and later acquired control of this property. His father was superintendent of Gold Run for years. He says that large quantities of gold were shipped direct to the mint or to Selby smelter to obtain full value for it.

The top gravel has been washed off this deposit for a depth of 40 to 80 yards, this latter being the height of the ridge of gravel left to carry the railroad and highway. Near this bank in 1905 and 1906 some twenty Chinese washed some fallen gravel. They paid \$10,000 gold for the lease, also paid \$5,400 for water to wash it and were well satisfied with the results obtained. From a consideration of the water used and its probably duty, Mr. Stewart estimated that this gravel yielded 20 cents per cubic yard.

Value of Undrifted Hydraulic Bottom Gravel (Cemented) at Gold Run.

The following is the account of a gold bar obtained from work in June and July, 1908, on a bank of gravel 80 feet high that had not been drifted. This is the only bulk sample that we have record of.

Date: August, 1908—Weight of bar 3257.91 oz. Value \$64,564.81. Gold fineness 902.

Obtained from 15 head boxes and undercurrent. The lower boxes were not cleaned up.

Height of bank: 80 feet.

Water used: 2000 miner's inches at 450 feet head.

Duration of run: 60 days of 24 hours each.

35 men employed.

* I have not been able to find any direct confirmation of this statement.

** Resources of the United States West of the Rockies, 1867, p. 101.

*** This is probably a quotation of Turner's estimate (see the Table on page 41).

Powder used : 5500 kegs of 25 lbs. each.
Dynamite used: 7500 lbs. of 40%.
237,400 cubic yards of gravel washed by actual measurement of the bank by surveyor.
This is equal to **27.2 cents per cubic yard.**
Duty of the miner's inch 1.98 cubic yards.

Value of Drift Gravel of Bottom Ground at Gold Run.

Drifting operations in 1906 gave values shown by the following table. Each car held about 16 cubic feet of gravel which would be equivalent to about 27 cubic feet or one cubic yard of gravel in place, as the boulders were stacked behind in the working places.

Date	Quantity	Production	Dollars per cubic yard	Remarks
Apr., 1906-----	301 cars	\$1,595 81	\$5 30	Drifting above bedrock. Going north.
May, 1906-----	207 cars	504 00	2 43	
June, 1906-----	129 cars	120 50	0 94	Half of this was on bedrock.
Oct., 1906-----	392 cars	1,590 71	4 06	
Nov., 1906-----	472 cars	1,933 00	4 10	
Jan., 1907-----	122 cars	355 00	2 91	
Feb., 1907-----	165 cars	1,293 92	7 85	
Totals-----	1,788 cars	\$7,392 94	-----	

Average \$4.13 per car or per cubic yard of gravel in place.

The above data enables us to obtain some idea of the value of the gravel hydraulicked immediately above the bottom drifting gravel. The drifts would be about 2 yards in height, so we calculate as follows:

Calculation:

80 yards of gravel at 27.2 cents-----	2176 cents
2 yards drifted at 413 cents-----	826 cents
-----	-----
78 yards hydraulic gravel would carry-----	1350 cents

This is at the rate of 17.3 cents per cubic yard.

From the 1600 foot tunnel 4375 cubic yards were taken that yielded \$9,578.60 or \$2.24 per cubic yard; over half of this material was two to seven feet above bedrock. This is from ground that will later be hydraulicked.

The following particulars are given by Mr. Stewart from his personal recollection or from notes: The Cement Mills Company mined 80,000 cubic yards of gravel by drifting under Indiana Hill at the south end of the property and it yielded \$750,000 which is over \$9 per cubic yard. The General Thomas Placer Mine on Indiana Hill produced \$150,000 from 17,100 cubic yards of gravel mined by drifting; this is over \$8 per cubic yard. These returns are interesting but they represent gravel at the south end of the property and therefore away from the direction of future work.

The Indiana Hill Placer Mine was one of over twenty that were working in the big pit mentioned on p. 42. Mint returns for three seasons show the following figures for this one mine:

1876	----\$	24,091.68	
1877	----	19,636.35	
1878	----	93,784.96	
1879	----	14,712.91	—this last figure was for the January clean-up only.
Total		\$152,225.90	

Value of Gravel Remaining to Be Hydraulicked.

Summarizing the foregoing statements: The first gravel washed was light surface material and Pettee estimated it at 4.65 cents per cubic yard; **this has all gone.** The next 40,000,000 cubic yards is reputed to have been 11-cent material as already quoted. The cemented gravel below this may be up to 80 feet thick and carry 17.3 cents per cubic yard, with drifting gravel below that carrying \$2 to \$4 per cubic yard, if it has not already been drifted.

Question: To what extent are we justified in applying these values to the gravel remaining? They apply to the 27,436,000 cubic yards remaining on the southern part of the property, that being where this hydraulic and drift work was done. This yardage at from 11 to 17 cents without counting undrifted bottom gravel that would raise the returns above 17 cents constitutes a very fine mine. Beyond this, at the northern end, work stopped for lack of grade, tunnels being required from Cañon Creek at the lower end to give grade. These tunnels are now available because of the consolidation of the properties into one, and would suffice to work a large area, but an additional tunnel would be required for the extreme north end. This north end, estimated to contain 47,600,000 cubic yards, should pay well under the new conditions as there has been no drifting done on it. The only way to tell whether there will be more or less gold than at the south end is to work it or put down trial shafts for sampling tests.

Storage is required and is justified for whatever amount can be worked in twenty years or the period considered. The first 27,000,000 should yield from 11 cents to 17 cents per cubic yard and the remainder should exceed these values as no drifting has been done in that area.

Water Available and Rate of Work Expected.

Upon this will depend the storage required for the first twenty years. The amount expected to be mined in other deposits on the same river must be considered also.

1600 miner's inches from Rattlesnake Ditch, giving 400 feet of pressure head.

This flow is maintained for five to seven months, the water coming from Cañon Creek through 5 miles of ditch.

Total water for 5 months each of 26 piping days= $1600 \times 5 \times 26 = 208,000$ M. I. D.

Total water for 7 months each of 26 piping days= $1600 \times 7 \times 26 = 291,200$ M. I. D.

Average: 250,000 M. I. D. for the season.

To work this property to the best advantage a larger supply of water should be developed for a longer season.

The upper gravels at Gold Run gave high duty per miner's inch, the middle gravel is slightly cemented but crumbles readily when the bank falls or is shaken by powder blasts, and the bottom gravel is more strongly cemented. We, therefore, cannot use a high duty in calculating yardage expected to be moved.

The duty of 1.98 already recorded was from bottom gravel that was cemented and required crumbling by blasting. There is some

bouldery material that would give a lower duty, but there is also medium gravel that would give a higher duty. An average of 2 may be expected and has been used for the purpose of this estimate; $250,000 \times 2 = 500,000$.

Gold Output Expected.

The bottom gravel that has been drifted would yield 17 cents and if undrifted, up to 27 cents.

The middle gravel would equal the general estimate of 11 cents, mentioned by Lindgren.

The mean of 11 and 17 is **14 cents** and the mean of 11 and 27 is **19 cents** and at these figures 500,000 cubic yards would produce from \$70,000 to \$95,000 for the season. Drifting has proceeded along the channel as described, but not always on bedrock, and breasting has not been carried right across the channel. The returns in undrifted ground may exceed 19 cents.

In 20 years 10,000,000 cubic yards could be worked with the present water supply and produce \$1,400,000 to \$1,900,000. In the table a mean figure of \$1,650,000 has been used.

The development of additional water will enable this output to be exceeded without difficulty. There is plenty of gravel workable with the present tunnels.

Other Mines on the North Fork of American River.

IOWA HILL.

The ground upon which the town stands is a narrow ridge, the gravel having been washed away from it on both sides. It is unlikely that the houses at Iowa Hill would be removed to enable gravel to be worked as most of them are occupied.*

There are some banks of gravel left without lava cover, but in many places the work proceeded up to and under heavy thicknesses of barren volcanic material. These places would be unlikely to be profitable under present conditions.

At Independence Hill the face of the gravel bank on the north side shows a large trough that has been filled with andesite and tuffs. Roach Hill was worked until the cover of andesite was very thick. On the south bank of Indian Creek there is a succession of hydraulic pits that form an almost continuous coastline for a length of two miles. In some places these pits do not go far into the bank but at the Morning Star claim work was stopped by the thickness of the cover; drifting then proceeded for years and in 1899** connected with drifts from mines at Wisconsin Hill 3000 yards away. There, from pits of the Gleason, and the Waterhouse and Dorn or Big Dipper, a very large amount of gravel was removed, but a large amount of bottom gravel was left at the latter mine. These banks show a readily washed gravel, with no lava capping, there being over 12,000,000 cubic yards readily available in the immediate vicinity of the pits. As drifting operations have proved that this gravel passed through to the Morning Star side it should be workable with profit until the lava

* Many of these old mining towns were built upon good gravel, sometimes on the best part of it, right in the center of the channel: Iowa Hill, Little York, St. Louis, Wisconsin Hill, Michigan Bluff, Dutch Flat, Relief Hill, Omega, You Bet.

** Lindgren, p. 149.

cover becomes too thick, and this figure may be exceeded. Previous returns show 5 to 7 cents per cubic yard but good profit was made because of the high duty per cubic yard.

In the table Iowa Hill and Wisconsin Hill together are credited with 20,000,000 cubic yards of workable gravel that should pay. If a dam be provided upon the North Fork American River at Owl Creek or some lower position these deposits would be worked because there is no large power or irrigation project using the water. Most of it is still available for mining.

Mr. I. E. Rose, part owner of the McGeachin Placer Mining Company (owning the Big Dipper Mine) surveyed this property in 1915 to determine the hydraulic gravel available. He estimated that 7,000,000 to 8,000,000 cubic yards had been washed away and 32,000,000 could be washed without trouble from overburden, and another 6,000,000 with overburden, making 38,000,000 in all. He estimated that it would contain 12 cents per cubic yard. The Gleason Mine adjoining it has had about 25,000,000 cubic yards washed away and would yield another 5,000,000. Previous operations here yielded about 15 cents per cubic yard.

In 1880 the mines at Iowa Hill used over 133,000 M. I. D. Very little water has been taken up for power and a larger amount could be developed for mining. The bottom gravel is partly cemented but would give a duty of 2, and the upper gravels a very much higher duty. In the IX Report of the California State Mineralogist, Mr. John Hays Hammond reported the duty obtained at the Hobson mine as 24 cubic yards per M. I. D. using 12 inches grade for a 12 ft. box. Cemented gravel gave a duty of 10. At Wisconsin Hill using the same grade in the sluices a duty of 10 was obtained, and 3 on cemented gravel.

Probable Yardage and Yield for the Season.

Calculating on 1000 miner's inches for a season of 150 days and an intermediate duty of 4 we should obtain a season's yardage of $150,000 \times 4 = 600,000$ cubic yards. The district as a whole should readily attain this.

The second report of the State Mineralogist (1882) gives the yield from some of these gravels in some Notes on Hydraulic Mining by E. W. Robinson, page 170.

The Morning Star Mine gave 37 cents per miner's inch and moved 5.61 cubic yards per miner's inch. This is equivalent to 5.6 cents per cubic yard.

The Orion yielded 50 cents per miner's inch and moved 10.19 yards, which is equivalent to about 5 cents per cubic yard of gravel.

The Sailor's Union Hydraulic Mine yielded 10.7 cents per cubic yard and the Vaugh claim 34 cents (Whitney p. 117). In most cases there is no reliable record of the values. It is probable that the yield would be much greater than 5 to 7 cents, as the Big Dipper was not worked to bedrock at that time.

The Lost Camp Mine in Blue Cañon would be benefited by a dam in the North Fork American River. It was worked in 1916, using water purchased from the Pacific Gas and Electric Company at 10 cents per M. I. D. (see Mines and Mineral Resources of Placer

County, California State Mining Bureau, Dec. 1916, p. 106). The Park and Brown Mine would also work on this river using water from Deep Creek, (see the same report, p. 107).

FOREST HILL.

In Lieut. Col. Mendell's report of 1881, Ex. Doc. 98, p. 109, Andrew Larson, giving an estimate for Forest Hill, northern part, says: "This part was most difficult to estimate because it is all covered with lava, excepting a very small space, and the hydraulic working depends upon how far the lava material keeps soft; when it gets to be rocky or hard the hydraulic mining is finished. He allowed a possible 19,360,000 cubic yards."

The 1891 report of the Board of Engineers (Ex. Doc. No. 267, p. 85) estimated that 6,000,000 cubic yards are available, and with tunnels 12,000,000 might be developed. For Smith's Point and Yankee Jim's, 3,000,000 to 5,800,000. These mines on the north side of the Forest Hill Ridge discharge into Shirttail Cañon, which joins the North Fork American above the site most favored for building a dam. Unfortunately there is little likelihood of hydraulic work on this side of the ridge, although previous reports say that there would be some.

Yankee Jim deposits are finished; Georgia Hill on the other side of Devil's Cañon has been worked inwards until one-half of the bank shows andesite capping as thick as the gravel, and the cover on the other half will increase rapidly. Nevertheless, residents of Forest Hill expect hydraulic work to be done here. Smith's Point, east of Yankee Jim's, shows two spurs of gravel that would be easily washed in continuance of old work, but this is not where values seem to have been high. The greater part of the hydraulic work was carried on along the run of a well defined channel until the andesite cover was very thick. This is shown in two pits. At the Mayflower a lot of shallow hydraulicking was done, large areas of top gravel were removed until a layer of tuff was met that seemed to form a good substitute for bedrock for washing operations. A large pit was thus formed round the site of the Mayflower shaft and also in other places.

I have not counted on any yardage from these places, but if work started the debris produced would be accommodated by a dam on the North Fork American River at the Owl Creek site on the North Fork site.

Forest Hill was carefully surveyed and reported upon by Ross E. Browne in 1890, see X Report of the California State Mineralogist, and by John Hays Hammond in 1889, see IX Report of California State Mineralogist, p. 105.

An excellent map of the district was published with that Report, likewise one of the Iowa Hill field.

Forest Hill is essentially a drift mining district. Its mines have been rich, and the map shows mining claims at the old town on the south side of the ridge below the present town, narrower than those on any other field. The ability to hydraulic for a while to uncover the bedrock and determine the run of the channel may be of great assistance to subsequent drifting. This makes it simpler to determine where bedrock tunnels should be started in order to arrive under the center of the channel and have enough grade.

LOST CAMP.

This mine in Blue Cañon was not inspected. It has been worked with water bought from the Pacific Gas & Electric Company's ditch at 10 cents per M. I. D.*

10,000,000 cubic yards are claimed to be available. Debris is restrained by a wire basket fill dam. To pay when worked in the above manner, the contents probably average 15 cents per cubic yard.

Annual yardage would depend upon water available over and above the needs of the Pacific, Gas and Electric Company.

50,000 cubic yards at 15 cents=\$7,500.

In 20 years the output would exceed \$150,000, probably by a large amount, dependent chiefly on water available.

*See also Mines and Minerals of Placer County, California State Mining Bureau, Dec., 1916, p. 107.

GRAVELS OF THE MIDDLE FORK OF AMERICAN RIVER.

Estimates of Gravels on Middle Fork of the American River—Quantities in Millions of Cubic Yards.

Name of report.....	Whitney	Mendell	Board of Engineers	U. S. G. S.	This report
Engineer.....	(Pettee)	(Larson) Ex. Doc. No. 98	(Turner) Ex. Doc. No. 267	(Lindgren) Prof. Paper 73	(Jarman)
Year made.....	1879	1881	1891	1911	1926
Forest Hill, South Side.....	No estimate	No estimate	-----	No estimate	-----
Paragon (Bath).....	No estimate	No estimate	24.5	-----	Over 15
Dardanelles and Baltimore.....	No estimate	No estimate	5.5	No estimate	Over 3
Todd's Valley and Spring Garden.....	No estimate	No estimate	5.0	No estimate	Nil
Michigan Bluff.....	No estimate	No estimate	-----	-----	-----
Big Gun.....	No estimate	No estimate	23.1	No estimate	Over 3
Sage Hill.....	No estimate	No estimate	-----	-----	Not estimated
Totals.....	-----	-----	58.1	-----	Over 21

Rate of Work Expected on the Middle American River and Production for the First Twenty Years.

Mine	M.I.D. available	Duty	Per annum		Twenty years	
			Yardage	Yield	Yardage	Yield
Forest Hill, South Side:						
Paragon (Bath).....	110,000	4	440,000	\$44,000	8,800,000	\$880,000
Baltimore and Dardanelles.....	40,000	2	80,000	10,400	1,600,000	208,000
Michigan Bluff:						
Big Gun.....	72,000	2	144,000	12,960	2,880,000	259,200
Sage Hill.....	Not estimated	-----	-----	-----	-----	-----
Totals.....	222,000	-----	664,000	\$67,360	13,280,000	\$1,347,200

Middle Fork of American River.

MICHIGAN BLUFF.

The Big Gun. In this district there is the Big Gun mine with 400 miner's inches available. For a season of 180 days this gives 72,000 M. I. D. One bank of gravel here contains over 2,000,000 cubic yards. There is also the site of the old town which was built on gravel. Only the bottom gravel is cemented and the duty obtainable would be 2 or more. This mine is mentioned in Ex. Doc. 267, p. 93, as difficult to work (the reasons are not given) and as having been sold to satisfy judgments. Nevertheless it is still fitted up to work (1926) and negotiations are under way for working it again. The yield of the gravel is not recorded, and it has been assumed as 9 cents per cubic yard. The ground falls rapidly to the river so that grade would not be difficult to obtain.

Keokuk Point, about 1 mile west of this has been completely worked off and the bedrock cleaned.

Sage Hill, two miles to the west shows gravel on several points or spurs jutting out into the canyon of Birds Valley. These deposits are irregular and so much overgrown that no estimate of quantities was possible. Some hydraulic prospecting was being carried on.

SOUTH SIDE OF FOREST HILL.

Mines on the south side of Forest Hill drain into the Middle American River.

Baltimore and Dardanelles. At the Dardanelles there is a bank of gravel left because the reservoir was above it. To the east of this the Baltimore has a point on which there is estimated to be at least 2,000,000 cubic yards. The Dardanelles formerly yielded 13 cents per cubic yard.* This gravel is cemented but would wash readily at a duty of 2 after blasting. 48,600 M. I. D. were used in 1880. Much more would be available if the ditches were cleared.

The Paragon Mine at Bath (also called the Breece and Wheeler) could easily be fitted for work and has two ditches. The Tod's Valley or Pond ditch with 600 miner's inches from Volcano Cañon and the Breece and Wheeler Ditch with 1500 miner's inches from El Dorado Cañon; 113,500 M. I. D. from these streams were used on this side of Forest Hill in 1880. No water has been taken for other purposes on this ridge, and more water would be available as the mines on the north side of Forest Hill would not be using it, but the ditches would need clearing. From 1874 to 1879 this mine was worked by hydraulic method only and produced \$243,075.87 from which dividends were paid amounting to \$119,670.14. This yield of gold equalled \$2.54 per miner's inch of water used, a high return (see Ex. Doc. No. 98, p. 24). The IX Report of the California State Mineralogist records that a bank of gravel 70 feet high gave 74.2 cents per cubic yard 124,000 yards yielding \$92,000.00. Another bank 71 feet high gave 78 cents per cubic yard, 22,275 yards yielding \$17,387.78.

When hydraulic work was stopped, this mine was drifted at the bottom or Blue Lead and also on a richer pay streak called the Paragon 160 feet above bedrock and a third streak called the Orono; from these it gave regular returns.

As a result of this drifting, future hydraulic results would be lower. The bottom gravel contains many large boulders, some being granite. The ordinary gravel contains pebbles stained green with chlorite, which the miners say is a very favorable indication for gold.

Above the gravel there is a cover of tuffs and then andesite. This would reduce the returns, but the andesite has been eroded so that the amount of cover would not increase much for 100 yards of work behind the present bank. Gravel miners consider this mine is rich, but the barren cover must be moved. When drifting had been carried on for 3850 feet, a barren channel filled with volcanic material was encountered (Whitney p. 94). Drifting was done over a width of 200 to 300 feet and the trough was stated to be 4000 feet wide.

About 15,000,000 cubic yards could be worked without trouble from the andesite cover. The yield is difficult to forecast. In many districts the old miners piped away the overburden and lighter top gravel and got rid of it as fast as possible. Having done this they prepared to pipe the "gravel" and if they estimated the quantity of gravel piped or the returns from a bank it was usually "pay gravel" that they considered. Top stuff was only cover or surface material,

*Ex. Doc. No. 98, p. 23.

not worthy of consideration. A bank of 70 feet carrying 76 cents per cubic yard, covered with 100 feet of light gravel probably 15-cent material, and 200 feet of barren tuffs and andesite which the bank now shows would average 18 cents per cubic yard for the whole bank. Ten cents has been used for this calculation because the large amount of drifting that has been done would reduce the former values considerably.

Assuming the ditches to have half capacity there would be 1000 miner's inches, and a season of 180 days would give 180,000 M. I. D. In 1880 there were 113,000 M. I. D. used in this district. 110,000 M. I. D. has been assumed and a duty of 4 (there is plenty of grade and $\frac{3}{4}$ of the bank is easy to move).

The season's work would be:

110,000x4=440,000 cubic yards,
and the yield would be:
440,000x10c=\$44,000.

The production of this mine when hydraulicked was about \$55,000 per annum.

GRAVELS OF BEAR RIVER.

Estimates of Gravels on Bear River (Including Greenhorn and Steephollow)—Quantities in Cubic Yards.

Name of report-----	Whitney	Mendell Ex. Doc. 98	Board of Engineers Ex. Doc. 267	U. S. G. S. Prof. Paper 73	This report
Engineer-----	(Pettee)	(Larson)	(Turner)	(Lindgren)	(Jarman)
Year made-----	1879	1881	1891	1911	1926
Lowell Hill-----		None	1,200,000		
Liberty Hill-----		1,645,600	6,000,000 to 10,000,000	16,000,000	Over 4,500,000 ?
Elmore Hill and Nary Red-----		Nil			
Dutch Flat: Polar Star Channel Gold Run Channel-----	No estimate	8,500,000	30,000,000 to 36,000,000	Much less than 90,000,000	4,710,000 17,286,000 to 34,573,000
Christmas Hill-----	No estimate	605,000	1,500,000		Over 440,000
Little York-----	No estimate	484,000	1,600,000	Nearly finished	Over 3,000,000
You Bet (including Red Dog, Nevada, Niece and Wests, Brown Hill)-----		9,680,000	30,000,000 to 75,000,000	100,000,000	20,000,000
Walloupa-----		4,840,000			Too cemented
Chalk Bluff-----		(Sailor Flat) 4,840,000			
Buckeye Hill-----			4,000,000	Nearly finished	Over 5,000,000
Hunts Hill (or Gouge Eye)-----		2,420,000	to 5,200,000		
Quaker Hill-----		16,262,400	90,000,000	140,000,000	
Remington Hill-----		484,000	1,000,000 to 6,000,000		
Excelsior Point-----					
Pleasant Hill-----		58,080			
Wolf Creek Basin-----			100,000 to 500,000		
Totals-----		49,819,080	121,100,000 to 227,000,000		Over 32,940,000

Rate of Work Expected on Bear River and Production for First Twenty Years.

Mine	M.I.D. available	Duty	Annual		Twenty years	
			Yardage	Yield	Yardage	Yield
Lowell Hill and Liberty Hill	275,000	1½	350,000 to 525,000	63,000 to 94,500	7,000,000 to 10,500,000	1,260,000 to 1,890,000
Foss-----	30,000	2	60,000	5,400	1,200,000	108,000
Little York and Christmas Hill-----	75,000	2	150,000	22,500	3,000,000	450,000
Elmore Hill, Dutch Flat, Polar Star, Southern Cross, Je- hoshaphat, etc.-----	*	1			†	
You Bet , Brown's Hill, Wal- loupa, Red Dog, Nevada Hydraulic-----	380,000	1½	570,000	85,500	11,400,000	1,710,000
Hunt's Hill, Quakers Hill-----	54,000	2	108,000	16,200	2,160,000	324,000
Totals-----	760,000		1,238,000 to 1,413,000	192,600 to 224,100	24,760,000 to 28,260,000	3,852,000 to 4,482,000
Average-----			1,325,500	\$208,350	26,510,000	\$4,167,000

*Purchased from P. G. E. Co. ditch or developed from other sources.

†Output not calculable until water available is known.

In 1880 the total water used for hydraulic mining on Bear River was 1,117,082 M.I.D. which was estimated to have duty of 3, giving an annual yardage of 3,351,246. There was a large volume of top gravel in this, the yield from which would be low.



Photo by Arthur Jarman.

LIBERTY HILL MINE, ON BEAR RIVER.

This mine has worked intermittently since the injunctions, debris being caught in a log crib and rock-fill dam opposite Dutch Flat. The dam has been raised from time to time to increase its capacity. A concrete dam will enable steady work to proceed on all mines on that river.

BEAR RIVER.

LIBERTY HILL AND LOWELL HILL.

A channel from Lowell Hill runs through Liberty Hill, crosses Bear River to Elmore Hill, then crosses Little Bear Creek to the Polar Star Pit and thence joins the main channel at Dutch Flat. The gravel is readily traced over this country. At Lowell Hill much drifting has been done and some hydraulic work.

SWAMP ANGEL MINE.

Some preparations were made to hydraulic in 1921 and 1923 but the small concrete dam built for this purpose became filled with tailings brought down by freshets.

FOSS MINE.

Preparations are under way for hydraulic work. The owners claim to have a large yardage on this channel and propose to use 30,000 M. I. D. per season at the commencement of hydraulic work. The mine was not visited.

LIBERTY HILL MINE.

Liberty Hill is southwest of this and has been worked from time to time since injunctions obliged the miner to provide dams. There is a log crib and rock fill dam below Little Bear Creek on the Bear River which is used by this mine. A report by P. D. Burt made in 1916 estimated that 8,000,000 cubic yards was available that should yield 16 cents per cubic yard.

Reporting in 1925, L. A. Decoto estimated the gravel as averaging 19 cents per cubic yard, the top gravel giving a duty of 2 and the bottom a duty of one-fourth yard per miner's inch. The top material is easy to move and should do better than this, but the bottom gravel is often so cemented that it must be shattered by powder before attacking it by water. Various estimates have been made of the quantity of gravel that remains. The owner of the Liberty Hill Mine estimated 4,500,000 cubic yards on his ground alone.

Ex. Doc. 267, p. 85 estimates 6,000,000 to 10,000,000 cubic yards. Lindgren quotes 16,000,000 as remaining. The bank is only 40 to 80 feet high and about 600 feet width of channel is worked. This would mean 4,000,000 cubic yards in the next 1000 yards of channel.

The gravel appears to be continuous to Lowell Hill, a distance of about 4000 yards, all covered by timber. Six shafts put down near the rim to determine the width of pay channel are reported by Mr. W. Maguire to have averaged 15 cents per cubic yard. Three shafts were sunk ahead of the pit to determine the continuation of the channel and its values. Two have since been worked out.

The owner of the mine (Mr. W. Maguire of Nevada City) submitted figures showing that the mining of 1,200,000 cubic yards of gravel produced \$210,000 between the years 1896 and 1915. This is at the rate of 18.3 cents per cubic yard. The last work was in the season 1920-1921 when W. S. Bliss washed 131,049 cubic yards of top gravel for a return of \$18,192.81 and the glacial gravel underlying it was

afterwards blasted and piped, 21,500 cubic yards giving a return of \$17,526.61. These quantities of gravel were determined by survey by Mr. Uren. This is at the rate of 13.88 cents for top gravel and 81.5 cents for bottom gravel, and 23.4 cents average for the whole bank.

Rate of Work Possible.

2000 M. I. of water are available for a season of about 150 days and after that 500 M. I. for another 100 days.

$$150 \times 2000 = 300,000 \text{ M. I. D.}$$

$$100 \times 500 = 50,000 \text{ M. I. D.}$$

$$\text{Total} \text{-----} 350,000 \text{ M. I. D.}$$

At a duty of 1 to $1\frac{1}{2}$ cubic yards per M. I. D. this gives 350,000 to 525,000 cubic yards of gravel for the season. At 18 cents per cubic yard this would yield from \$63,000 to \$94,500.

DUTCH FLAT.

The channel from Liberty Hill crosses Bear River to Elmore Hill and Nary Red.* At the latter place hydraulic work has proceeded in several pits, the light surface gravel has been washed off, and some of the heavy gravel below it, exposing slate bedrock. The bank has been drifted. At Elmore Hill only the light upper gravel has been washed off. This hill is a direct continuation of the channel which can be seen to cross Bear River from Liberty Hill; from Elmore Hill it crosses Little Bear River and is seen on the opposite bank in the Polar Star Pit and so it passes on to Dutch Flat. All this area on the Dutch Flat Side (or south side) of Bear River would have to purchase water unless some new source of supply could be developed.

This fact coupled with the heavy nature of the bottom gravel and its cemented character makes future operations doubtful.

POLAR STAR.

This mine worked down to bedrock, as did the Southern Cross in one of its pits. The bottom gravel is 60 to 90 feet thick and is glacial, with large boulders and strongly cemented near the bedrock. Some of the boulders are over 10 feet in diameter. Figures given by W. H. Pettee showed that the top gravel yielded 11 cents, (Whitney p. 425). W. Nichols who owned and operated the Polar Star and Southern Cross up to and during the trouble with injunctions, figures that this gravel yielded 25 cents after having been drifted, the bottom portion yielding 40 cents.

The water used in the last work done here was purchased from the Pacific Gas and Electric Company's ditch and cost 10 cents per M. I. D. It is an open question whether this heavy bouldery cemented gravel would pay to work under present day conditions with water at this price. When washing heavy material the water duty is low, and after blasting the cemented gravel, an economical method of

*Nary Red means no red, the gravel being characterized by white quartz which is now shipped to brickworks and sometimes to smelters as a pure silica flux, about 98% SiO₂.

handling heavy boulders would be required. The mine should be credited with stacking this heavy material in the mine pit if a charge per cubic yard is made for impounding debris.

SOUTHERN CROSS AND FRANKLIN.

The Southern Cross Mine exhibits heavy glacial gravel in one pit where worked to bedrock. Elsewhere on this mine and in the Franklin, the old miners washed the lighter top gravel and left the heavy cemented bottom gravel. There is some of this lighter gravel available here, and in adjoining ground.

DUTCH FLAT.

After this Liberty Hill channel runs past the town of Dutch Flat, it joins the main Blue Lead, a little south of the town. The Blue Lead or big channel comes from Gold Run, crosses the railway and swings to the west past the town, crosses the Bear River, passing on to Little York. From here it crosses Steep Hollow, passes on to You Bet, and Red Dog, then crosses the Greenhorn and continues through Hunts Hill and Quaker Hill. All these gravels eventually find their way down Bear River if hydraulicked.

Most of the top gravel has been washed off at Dutch Flat; Lindgren (writing in 1911) says, 90,000,000 cubic yards of it and Turner (in 1891) in Doc. 267 says 105,000,000 cubic yards.

The area of gravel exposed is large. To estimate the yardage remaining, the central portion or main run of the channel was calculated and found to have an area of approximately 647,100 square yards, omitting some rim ground, and the area that the town occupies.

According to the positions of bedrock exposed by shafts and drifts, the depth of gravel on this area varies from 130 feet in the Southern Cross Pit to 200 feet on the main run of the Blue Lead, and is supposed to be 250 feet or more at the railroad. From this I calculate that 34,573,000 cubic yards of gravel remain. Information concerning the position of bedrock is meagre however, and some factor of safety is desirable. There is no evidence of faulting on the Blue Lead and the worst that could happen would be for the shape of channel to change from the flat contour that it exhibits near Bear River and at Gold Run, and assume a steeply sloping V shape. This is unlikely, but the effect would be to halve the quantity and give only 17,286,000 cubic yards. I therefore conclude that there is from 17,000,000 to 34,000,000 cubic yards of gravel on this ground.

These figures show that there is a problem worthy of attack, viz:—the beneficiation of this large volume of gravel.

Information concerning its gold contents between Dutch Flat and the railroad is meagre, but Lindgren (p. 144) says all this ground was drifted. Whether it can be worked at a profit cannot be told without further information. There is, however, a large amount of top gravel that would be easy to wash. In the table of available gravel, 17,286,000 to 34,573,000 of bottom gravel at Dutch Flat is included tentatively.

CHRISTMAS HILL AND LITTLE YORK.

Christmas Hill is a continuation of the Little York gravel. It is also known as the Baltimore Placer. The gravel is small and easily washed giving a duty of 4 to 5 cubic yards per miner's inch. It is reputed to yield 9 to 10 cents per cubic yard giving \$200 per day regularly when working with 500 miner's inches. An entry in the old accounts* showed that two months work in March and May 1877 produced \$7,984.86 when using 500 M. I. from Bear River ditch. The yardage moved would be approximately:

$$500 \times 4\frac{1}{2} \times 2 \text{ months} \times 26 \text{ days per month} = 11,700 \text{ cubic yards.}$$

The yield is therefore equivalent to about 6.8 cents per cubic yard.

The gravel remaining on the top bank contains 440,000 cubic yards by survey, and there is a lower bank not surveyed.

In the 1881 Report (Ex. Doc. 98, p. 108) the gravel for these areas was given as 1,089,000 cubic yards.

In the 1891 Report (Ex. Doc. 267, p. 85) Little York is credited with 1,600,000 and Christmas Hill with 1,500,000, a total of 3,100,000 cubic yards. The owner claims a much larger amount than this on Little York alone. There is the gravel occupied by the ruins of the old town, and this bank continues down the side of the channel. The bottom gravel is cemented, particularly the lower 20 feet. The top gravel is said to carry 8 to 10 cents and the cemented bottom gravel 20 cents.

LITTLE YORK.

This company's patent of 1872 included the Liberty Hill, Christmas Hill and Little York mines.

The following bullion figures were taken by me from bullion certificates and accounts of the old Little York Water and Mining Company, in the possession of Mr. W. Maguire of Nevada City.

April 21, 1873, to April, 1874, and then to Sept.,

1874, certificates, totalled----- \$96,228.81

Sept., 1874, to Dec., 1875—certificates totalled-- 71,191.78

Total from April, 1873, to Dec., 1875-----\$167,420.59

The new company transferred its office to San Francisco, 330 Pine Street, and all records there were burned in the fire of 1906.

Water Rights.

1400 M. I. for 6 months, there being about 26 piping days in the month. The yardage treated for the season with a duty of 2 yards per M. I. D. would be:

$$1400 \times 2 \times 6 \times 26 = 435,800.$$

The 29 months during which the above bullion was obtained would enable the following yardage to be washed:

$$\frac{29}{12} \times 436,800 = 1,055,600 \text{ cubic yards}$$

*Accounts of the Little York Company which owned this ground and the Liberty Hill as well.

A yield of \$167,420.59 would be at the rate of 15.8 cents per cubic yard, with a duty of 2 yards per miner's inch. The bottom gravel is strongly cemented, but the middle and top gravel is easy to wash.

Rate of Work and Yield Expected.

Using 75,000 M. I. D. from the Bear River Ditch or Maguire Ditch and averaging the duty between the upper and lower gravel at 2 cubic yards per M. I. D. there would be 150,000 cubic yards moved. At 15 cents this would yield \$22,500 for the season.

YOU BET DISTRICT.

Between Steep Hollow and Greenhorn, both tributaries of Bear River, the channel has been worked by mines famous in the early days of hydraulic mining, Brown's Hill, Niece & West, Walloupa, Nevada Hydraulic, You Bet, Red Dog, Husseys and Chalk Bluff. These are now consolidated under one ownership. Some excellent gravel remains, and work has proceeded at various times since the injunctions took effect. If the debris were taken care of by a dam, this property would pay to work.

Mr. William M. Strong, mining engineer of Denver, Colorado, examined the gravels in June 1915 and reported 20,000,000 cubic yards of gravel that will yield 10 to 15 cents per cubic yard. About 7,500,000 cubic yards would be discharged into the Greenhorn and the other 12,500,000 into Steep Hollow. Mr. Strong's estimate of the value of the gravel is based upon his own sampling and upon past returns from the mines. If the opinions of miners that have worked in this district may be expressed, this estimate of 10 to 15 cents is below what is expected by them. When hydraulic work was in full swing, there was difficulty in securing grade for sluiceboxes, because the beds of these two rivers filled with debris until the outfall of the boxes were choked. Both rivers from which water is obtained are short, their drainage areas being: Greenhorn $7\frac{1}{2}$ square miles and Steep Hollow $17\frac{1}{2}$ square miles.

The small sizes of these areas are partly compensated for by good rainfall in the higher part of the basin. Additional water might be brought from the South Yuba by a ditch that formerly brought water down the Chalk Bluff Ridge.

Concerning the Red Dog section of this property Mr. Strong reported that under the conditions of 1915 (necessitating impounding by their own dam) there was 3,000,000 cubic yards available. 26 rocker samples of this averaged 25.8 cents per cubic yard, and the cost of working he estimated at 10 to 15 cents.

Mr. F. A. Goodale was in charge of the You Bet property from 1915 to 1920. He says that of the $2\frac{1}{2}$ miles of channel there is still $\frac{3}{4}$ mile that is untouched, neither hydraulicked nor drifted. In the last operations at Brown's Hill, about 45,000 cubic yards was washed and produced \$10,000, a little over 20 cents per cubic yard. At the Red Dog 60,000 cubic yards produced less than \$10,000, but panning tests indicate 25 cent value. He considers 15 cents a safe estimate here. The Nevada Tunnel mine stopped in 1918 for lack of grade, 30 feet being required to give elevation in the sluices. This he esti-

mates as 20 cent gravel, and 15 cents may safely be calculated on. Summing up he says that there is from 12,000,000 to 24,000,000 cubic yards of 15 to 17 cent gravel that can be washed if a debris dam is provided.

Mr. H. B. Adsit reported in 1909 that this gravel would average 25 cents per cubic yard for a width of 500 feet and a depth of 25 feet all along the channel. This value was determined from panning tests and previous records.

Rate of Work Possible.

Water is brought in by three ditches, the English Ditch from Steep Hollow, capacity 1400 M. I.; the Irish Ditch from North Fork of Steep Hollow, capacity 1400 M. I.; and the Stehr Ditch from Little Greenhorn, capacity 1000 M. I. This is a total capacity of 3800 miner's inches and would give a large output if the ditches could be kept full.

The catchment areas of these streams is small and the water season would not last long after the rains stopped. A season of at least 100 days should be obtained, as the rainfall in this district is over 45 inches. This would give 380,000 M. I. D. for the rainy season, after which some work could proceed on a smaller scale difficult to estimate. One of these mines, the Nevada Hydraulic used 420,500 M. I. D. in 1880. 380,000 at a duty of $1\frac{1}{2}$ gives a yardage of 570,000 and at 15 cents this yields \$85,550. If grade can be maintained in the sluices, particularly at the Nevada Mine, these figures will be exceeded without difficulty.

HUNT'S HILL, QUAKER HILL, AND BUCKEYE HILL.

When the channel crosses Greenhorn River it continues northward to Scott's Flat on Deer Creek. Mines were worked between these rivers at Hunt's Hill (formerly called Gouge Eye) and northeast of this, at Quaker Hill. From Hunt's Hill the gravel also passes north under the lava and tuffs that cap the ridge emerging at Scott's Flat. This is on Deer Creek, a tributary of the South Yuba.

Opposite Hunt's Hill, on the other bank of the Greenhorn is Buckeye Hill which is only bench gravel and almost all of it removed.* Hunt's Hill and Quaker Hill both discharge into the Greenhorn, thence into Bear River. Quaker Hill gravels are described by Lindgren as being nearly 600 feet deep in the centre of the channel; 35,000,000 cubic yards worked off and 140,000,000 remaining. Turner in Ex. Doc. 267 says 35,000,000 worked, and from 50,000,000 to 90,000,000 remaining, but (p. 92) "unavailable for the greater part by lack of grade for the sluices." This difficulty prevents the richer deep gravels from being worked without elevators, but a shaft was sunk and some drifting done. The banks of the hydraulic pit have been worked in under the tuffs and andesitic material that covers the gravels. Considering all these things, the enormous amount of gravel recorded at Quaker Hill must be regarded as unavailable for hydraulic working under present conditions. Mr. Geo. C. Sargent who had the records of Quaker Hill, lost them in the San Francisco

*See Lindgren, p. 144, and Turner, in Ex. Doc. 267, p. 92.

fire of 1906. W. H. Pettee estimated the upper gravels here as carrying 6.6 cents per cubic yard.*

HUNT'S HILL.

Hunt's Hill gravel is continuous with that of Quaker Hill but a ridge of tuffs and andesite separates the mining pits.

Hunt's Hill workings are close to the river and bedrock is high enough to enable work to proceed without elevators. The bottom 40 or 50 feet of gravel is cemented, some of it strongly, and stamp mills were the rule for treating it.**

Turner (Ex. Doc. 267, p. 85) estimated that 6,750,000 cubic yards had been removed and 4,000,000 to 5,000,000 was still available. Most of this is cemented bottom gravel similar to that at You Bet and Red Dog, but there is also some light top gravel.

The water used at Hunt's Hill and Quaker Hill came from two ditches, the Union Ditch and Jacob and Sargents. The latter came from Greenhorn Creek, Whitney, p. 424 says Greenhorn Creek supplies 800 miner's inches per day for 9 months to the Quaker Hill Mine.

Mr. W. Maguire estimates that the two ditches supplied 1000 to 1200 miner's inches for a season of 150 days. Jacobs and Sargeant used 54,000 M. I. D. in 1880, according to Ex. Doc. No. 76. This small quantity of water with a duty of 2 would give 108,000 cubic yards for the season. At 15 cents per cubic yard this would yield \$16,200.

Summary of Bear River Grounds.

This district is hampered by lack of water and sometimes lack of grade for sluice boxes preventing work upon most promising gravels. The table therefore shows a large aggregate amount of gravel but a very small production from it.

Additional Water Supply.

The Cascade Ditch of the Nevada Irrigation District brings water to the old town of Quaker Hill at an elevation of about 3300 feet. The supply of water from this ditch affords hope of working more gravel at Hunt's Hill and at You Bet or Red Dog.

*See Whitney, p. 425.

**Mr. Thos. Brady at You Bet recalls stamp mills being used at the following claims: Mallory Bros., Hayward; Couzzen Bros., at Nevada Mine; Judge Barker, Old Red Dog, Bunker Hill (Brady's Mine), Turners (at Hunt's Hill), Carney and Goodspeed (where Chinese worked later at Hunter Hill), Sargent & Jacobs (at Quaker Hill).

GRAVELS OF THE SOUTH AND MIDDLE FORKS OF YUBA RIVER.
Estimates of Gravels on South Yuba and Middle Yuba Rivers—Quantities in Millions of Cubic Yards.

Name of report.....	Whitney	Mendell	Board of Engineers	U. S. G. S.	This report
Engineer.....	(Pettee)	(Larson) Ex. Doc. No. 98	(Turner) Ex. Doc. No. 267	Lindgren Prof. Paper 73	(Jarman)
Year.....	1879	1881	1891	1911	1926
South Yuba:					
North Bloomfield.....	700	No estimate	65	130	Over 50
Lake City.....			110	Probably 130	
Last Chanee, Porter and Brock- meyer.....			40		
Relief Hill.....			15	No estimate	15
Washington.....			3		Over 3
Blue Tent and Sailor Flat.....		4.84	30 to 60	90	2
Grizzly Hill.....		1			
French Corral.....		1			
Omega.....			20	40	24
Alpha.....				1	
Totals for South Yuba.....			283 to 313	400	Over 94
Middle Yuba:					
San Juan and part of American Mine.....			2.5		
Badger Hill and Cherokee.....			33		
Patterson.....			96		
Wolsey Flat.....			1.5		
Moore's Flat, Orleans Flat and Snow Point).....			14.2		
Totals for Middle Yuba.....			147.2		Over 442

Rate of Work Expected on South Yuba and Middle Yuba Rivers and Production for First 20 Years.

Mine	M.I.D. available	Duty	Per annum		For twenty years	
			Yardage	Yield	Yardage	Yield
South Yuba:						
Bloomfield Hydraulic and Lake City.....	650,000	4	2,600,000	\$260,000	52,000,000	\$5,200,000
Blue Tent.....	15,000	2	30,000	4,500	600,000	90,000
Relief Hill.....	120,000	3½	420,000	37,800	8,400,000	756,000
Washington.....	145,600	1	145,600	47,320	2,912,000	946,400
Omega.....	358,000	3	1,074,000	139,620	21,480,000	2,792,400
French Corral, etc.....			Not benefited by a dam		at Jones Bar	
Totals.....	1,288,600		4,269,600	\$489,240	85,392,000	\$9,784,800
Middle Yuba:						
Badger Hill or North Columbia Dis- trict, Moore's Flat District.....	650,000	4	2,600,000	\$260,000	52,000,000	\$5,200,000
Totals for Middle and South Yubas combined.....	1 938,600		6,869,600	\$749,240	137,392,000	\$14,984,800

SOUTH AND MIDDLE FORKS OF YUBA RIVER.

Between these two rivers lies the largest body of gold bearing gravel capable of being worked by hydraulic methods. It extends from Badger Hill to North Bloomfield, a distance of 9 miles. At the western end near Badger Hill the top soil and gravel was washed away from an area approximately four miles long and $\frac{1}{2}$ to $1\frac{1}{4}$ miles wide. This area extends from Badger Hill and Paterson to where Spring Creek crosses the deposit about a mile to the east of North Columbia or Columbia Hill.*

From Spring Creek the gravel continues eastward covered by trees and undergrowth for about a mile when we find the hydraulic workings of the Union Mine. To the east of this the gravel continues untouched through Lake City where it passes under an andesitic cover forming a ridge 400 feet high. About 3 miles from Spring Creek we reach the western bank of the hydraulic pit of the Bloomfield Hydraulic Mine (also known as the Malakoff Mine). In traversing this pit and the gravel at the far east end we travel another 2 miles before the gravel disappears under a cover of andesitic tuffs, lavas and breccia.

This brief description covers a gravel channel 9 miles long and $\frac{1}{2}$ to $1\frac{1}{4}$ miles wide, which contains over 800,000,000 cubic yards of gravel, computed from reliable survey data.

This enormous body of gravel was formed by several big rivers that joined each other in the course of the 9 miles. One came from the east and flowed west through Snow Point, Orleans, Moore's Flat and Derbec to North Bloomfield and so on down the big channel already described. Another flowed west through Omega and Alpha, then Relief Hill and on to Bloomfield and Malakoff and down the main channel described. A much larger river flowed north; it started from Michigan Bluff, passed through Forest Hill, Yankee Jim to Iowa Hill across to Indiana Hill and through Gold Run to Dutch Flat. Here it was joined by the Liberty Hill stream coming west, then on to Little York, You Bet and Red Dog, Hunt's Hill and Quaker Hill to Scotts Flat. From here it continued north but is covered by andesite and is found again at Sailor Flat and Blue Tent after which it crosses the course of the present South Yuba River to Grizzly Hill and joined the big channel at Spring Creek. Having combined their forces these rivers travelled as one big stream through the Columbia Hill area. Top gravel has been removed by mining from here down to Badger Hill. Further west the gravel was found and mined at North San Juan, Sebastopol, Sweetland, Birchville and French Corral, and again lower down the river at Smartsville. Most of the gravel at and below North San Juan has been worked but there are some banks that may be profitable if dams could be arranged and particularly at Smartsville and vicinity, where there is a large quantity of gravel which paid well in former times. The latter, however, lies below the damsite at the

*These two names are interchangeable; the post office is called North Columbia but the town is known as Columbia Hill, which leads to confusion until the visitor becomes conversant with the names, especially as old maps show Columbia Hill as a settlement 4 miles east of this.

Narrows, and at this place the Yuba leaves the Rocky gorge and widens into a broad stream that is difficult to dam.

The origin or formation of these gravels was interpreted in this way by early miners, the channels of each district being studied carefully as their drift mine workings show. River action, glacial action and sea beach action each had their advocates. We now know that glacial action was chiefly responsible for carving these valleys in slate and other bed rocks, often leaving remarkable evidence of ice action. Glacial gravel and morainal material frequently occupies the bottom of the trough; above this is found heavy river gravel and finer gravels, with sandy layers at times. Still higher are finer gravels, sands, tuffs and sometimes clays.

Geologists and others accustomed to record their observations in permanent form were attracted to these famous gold fields and we have Prof. T. D. Whitney's records of the examinations and data collected by Mr. W. A. Goodyear in 1871 and by Prof. W. H. Pettee in 1879, also those of engineers of the California State Mining Bureau, notably Henry DeGroot in "Notes on Hydraulic Mining," Report for 1880; Russell L. Dunn in "Drift Mining in California," Report for 1888, VIII; John Hays Hammond in "The Auriferous Gravels of California" in the Report for 1889, IX.

Still later, the U. S. Geological Survey assigned to Mr. Waldemar Lindgren the duty of studying this area and as a result we have his professional paper No. 73 published in 1911.

Whitney's Volume and Lindgren's Bulletin are both out of print and copies should be guarded with care by those lucky enough to possess them.

Geological features are of interest in enabling the reader to understand influences drawn from data gathered at the mines. All gravels vary in their gold contents on or near the bedrock of the stream, but the main bank of this enormous body of gravel is not likely to vary much in its gold content by reason of the averaging of conditions that occur in the deposition of so large a mass of material.

Mr. W. W. Waggoner of Nevada City, consultant to many gravel mines, has recorded and correlated all the known survey data relating to this area and submitted detailed maps which he made. He mapped the elevations of bedrock exposed by the action of water-courses and by mining drifts, shafts, drill holes, and by actual hydraulic work. In this way he produced a **contour map of the bedrock**. Having the contour of the gravel surface and also of the bedrock that lies below it, the quantity of gravel may be calculated with only a small percentage error. Such data also shows the shape of the deposit and makes it possible to determine the best method of attack.

Consideration of Different Methods of Working This Gravel.

It does not appear to be possible to work this gravel profitably by any method other than that of hydraulicking. The good values that lie in the lower gravel and on bedrock cannot be recovered by dredging as the depth of the deposit is too great—150 to 300 feet.

The largest dredges in the world are those of the Natomas Company of California operating near Natoma, and those of the Yuba Consolidated Goldfields at Hammonton on the Yuba, below the Narrows. The Natoma dredges have buckets of 15 cubic feet capacity and dig 150,000 to 225,000 cubic yards per month and operate at an average cost of $6\frac{1}{2}$ cents per cubic yard;* those of the Yuba Consolidated are of similar size and operate at a lower cost owing to exceptionally favorable conditions. These enormous dredges do not dig deeper than 86 feet, and values in this 86 feet probably will not exceed 6 cents per cubic yard. The gold is chiefly in the bottom layers and the gravel is 150 feet or more in depth; therefore, dredging would not pay, as the richer bottom gravel would be untouched. A plan to dissolve the gold from the gravel as it lies in place using cyanide as a solvent might be feasible but would be subject to percolation difficulties caused by thin layers of very fine sand or clay.

On the other hand hydraulic mining is a positive method that enables all gold to be cleaned from the bedrock and the crevices in it, and the operating costs are the lowest of any method of handling gravel and extracting its gold contents.

The costs at Bloomfield averaged 4.53 cents per cubic yard for the nine year's work. Wages are higher than they were at that time and supplies are more costly, also water; but making due allowance for these things the cost for the actual mining of such gravel should not exceed 7 cents according to engineers of the River Mines Company. The figure will depend upon the methods adopted to obtain a large output with the minimum of labor.

Mr. Waggoner calculates from his survey data that the area described contains 886,600,000 cubic yards of gravel. Another engineer using the same data but calculating by his own method reported 891,000,000 cubic yards. In 1876, while mining was active on this area, Mr. J. D. Hague, mining engineer of New York, estimated that 4400 yards length along the channel would contain nearly 300,000,000 cubic yards of gravel. The gold contents he estimated at from 6 to 12 cents per cubic yard, but this value was not determined by sampling; it was deduced from returns obtained from mines working along this ridge, which was famous as the 'San Juan Ridge.'

The larger area that we are considering he estimated contained 700,000,000 cubic yards. In making this estimate Hague was obliged to assume the contour of bedrock in places where data had not been obtained. Subsequent estimates made from fuller data show that his assumptions were justified.

Quantity of 'Workable' Gravel.

Mr. Waggoner's figure of 886,600,000 cubic yards represents the total gravel situated so that it would be possible to mine it, without consideration of ownership. Tunnels would be needed from the river banks to enable the gravel to be washed down sluices with sufficient "grade" or fall to give the water good transporting power. Small rim gravels in remote positions were left out of account in the above estimates.

*See Report XXI of California State Mineralogist, Jan., 1925, pp. 13 and 14.

Values Contained.

We next have to consider whether sufficient gold is present in this gravel to enable operations to pay. Obviously any gravel that is of too low grade to show a profit must be deducted, and similarly, gravel that shows too large a percentage of clay should be left out of account since clay is difficult to work and causes losses of gold from sluice boxes. Thick bands of clay or barren volcanic "tuffs" or of sand require high values in the remainder of the gravel to give an average for the whole bank that will be profitable. On this account the eastern bank of the Malakoff or North Bloomfield Mine would not be worked under the proposals now made, as the average values are too low to pay under the new conditions. There are two layers of clay each over 20 feet thick and there is also considerable sandy material. This eliminates from consideration all the gravel at the eastern end of the pit estimated at 86,700,000 cubic yards and leaves 799,900,000 to be considered. There is clay and sand at the western end of this area at Badger Hill, but prospecting operations indicate that gold in the gravel is sufficient to sweeten the average up to 10 cents. The general average from the western bank of the Bloomfield Hydraulic or Malakoff Pit to the far western end at Badger Hill is expected to yield from 9 to 12 cents per cubic yard along the middle of the channel.

Rate of Work Possible.

At this point it is well to call attention to the fact that this enormous bulk of material that can only be worked at a moderate rate. So that although 800,000,000 cubic yards is available it will not be possible to work more than one-eighth of it in the first 20 years under the plan now proposed.

The water available for work by the River Mines Company that owns most of the ground is about 1,300,000 miner's inch days per season. To this must be added "way water" or water picked up on the way down the ridge. Further supplies could be developed from the Middle Yuba but would require considerable capital. This might be done after the available supplies are fully utilized, which would take several years to accomplish, but for the first 20 years I have taken an average of 1,300,000 M. I. D. as the available water supply. With the best methods and with grades of $4\frac{1}{2}$ per cent in the sluice boxes, a duty of 5 may be maintained on this gravel, but as a matter of caution, 4 has been used for these estimates, i.e. 4 cubic yards of gravel washed per miner's inch day of water.

This gives $1,300,000 \times 4 = 5,200,000$ cubic yards as the bulk of material that could be washed per season. At this rate 800,000,000 cubic yards would take over 150 years to exhaust. Therefore, it is no use to talk volubly of the enormous amount available, or of the \$72,000,000 to \$96,000,000 in gold that it is expected to produce. For the present it is sufficient to make plans for mining a portion of this area with the facilities that are within reach, calculating for 20 years immediately succeeding the erection of a dam at the Narrows, on the Main Yuba. The plan first considered required 3 dams, one on

the Middle Yuba near Freeman's Bridge, another on the South Yuba near Norton's Cañon and a third at Shady Creek, (Jones Bar), after that at Norton's Cañon has been almost filled. The preliminary estimates of costs given in Table II, page 16, showed that this plan was far too costly.

In 20 years it would be possible to mine 104,000,000 cubic yards and produce from \$9,360,000 to \$12,480,000. It would take several years to attain this rate of work. The ditches and flumes at the headwaters carry about 5500 miner's inches and would have to be enlarged to carry the full amount of water available.* Thus, there would be a period of several years during which work would be on a smaller scale, increasing as more water became available and as the hydraulic mine pits were developed to utilize it. New tunnels and sluices would be required to carry the gravel, and hydraulic pits would have to be opened at the heads of these tunnels. The gravel mined would increase until it exceeded 5,200,000 cubic yards per season. The total for 20 years would probably be 104,000,000 and the gold output \$10,400,000.

Gravel Available and Values in the West Bank of Bloomfield Hydraulic Mine.

At the east end of the ground described we have the mine known as the Malakoff, North Bloomfield or Bloomfield Hydraulic. The latter is the correct name. It has already been explained that it would not pay to work the eastern end of this pit under the new conditions because of clay and tuff in the bank of gravel which reduced the value per cubic yard. After 1878 all mining proceeded eastward as the bedrock rises going east, and the western bank ran out of grade. The western bank was washed through what was known as No. 8 shaft on the line of the Humbug Tunnel and the mine is called No. 8 in the reports of Hamilton Smith, Jr., General Manager for the North Bloomfield Company. This tunnel was completed in 1874 and a raise put up to surface. The gravel was washed through this, mostly surface and middle gravel for the first year, next year a little bottom gravel as well, and the third year 1876-77, bedrock was well exposed and the mine was worked both to the east and west. The effect of the richer bottom gravel is shown by the higher returns. Next year there was no work westwards as they had run out of grade. In 1877 the bottom 65 feet of gravel was washed separately from the top 200 feet, and yardage was computed from surveys with the following results:**

Top gravel 1,591,730 cubic yards yielding 3.8 cents per cu. yd.

Bottom gravel 702,200 cubic yards yielding 32.9 cents per cu. yd.

The annual reports of W. Hamilton Smith, General Manager of the North Bloomfield Company, are the best statistics of the work of any company that operated on a river leading to the Grand Valley of California. From them and from other data Mr. Waggoner prepared the following table which shows that in nine years 26,619,571 cubic yards yielded \$2,611,800.17 or a rate of 9.81 cents per cubic yard.

*In 1876 Mr. J. D. Hague reported that 1,500,000 M.I.D. were actually delivered to mines by the ditches on this ridge.

**See Hydraulic Mining by Bowie, p. 74.

Statement of Yield from North Bloomfield Mine.

Year	M.I.D. water used	Duty, cubic yards per M.I.D.	Yardage	Yield	
				Value	Per cubic yard
1875-----	465,822	*4.8	2,235,946	\$ 83,078 63	\$0.0272
1876-----	786,200	*4.17	3,278,454	200,366 54	.0611
1877-----	597,000	*3.86	2,304,420	291,125 42	.126
1878-----	796,499	*3.7	2,947,046	311,276 70	.106
1879-----	919,008	†3.6	3,308,429	331,759 76	.10
1880-----	945,550	†3.6	3,403,980	287,924 18	.085
1881-----	744,600	†3.6	2,680,560	236,935 14	.088
1882-----	988,250	†3.6	3,557,700	386,146 23	.108
1883-1884-----	806,399	†3.6	2,903,036	483,187 57	.166
Totals-----	7,049,328	3.77	26,619,571	\$2,611,800 17	\$0.0981

*Determined by survey.
†Assumed approximately same as previous work.
In 1881 mine suspended for 4 months by injunction.
Last line, 1883 to 1884, is to February 1, 1884, when closed by permanent injunction.
During 1870-1874, 3,250,000 cubic yards of top and side gravel were washed from various places yielding \$96,700, making the total yield \$2,829,869.59 or 9.1 cents per cubic yard.



Photo by Arthur Jarman.

MALAKOFF, OR BLOOMFIELD HYDRAULIC MINE.

Debris from this mine will be restrained by a dam at the Narrows on the main Yuba. This mine yielded at the rate of 9.8 cents per cubic yard for nine years before injunctions were issued, see table printed above.

The low returns of the first two years were due to the large proportion of top gravel washed in the process of opening the pit. The higher return of the third year shows the effect of including bottom gravel when working on bedrock both east and west. The continuation of this gravel westward is assured and the estimates of quantity are based on survey data recorded by Mr. Waggoner.

In assigning a value to this material I have assumed a continuance of the value 9.8 cents because there has been no testing by prospect

shafts to the west of this bank. If there had been, it is a question whether the results would more truly represent the value of the next fifty millions of cubic yards that it is intended to work in twenty years than the yield from washing 26,600,00 cubic yards. As a matter of precaution new ground should be tested by washing gravel excavated from test pits or sampling shafts. In this case no sampling has been done and the gravel is calculated at 10 cents in estimating the output on the South Yuba. Much rim gravel was washed in former work, but even so the values obtained averaged 9.1 cents per cubic yard. In future, selective mining will be used, operations being confined to the center of the channel, thus leaving low grade rim gravels untouched. Working in this way the engineers of the River Mines Company expect yields of 10 cents per cubic yard.

The contour of the bedrock shown by Mr. Waggoner in his map of this ground shows a slight increase in grade going west to Lake City. This, together with the junction of a channel coming in from the north, would favor increase in values as the work on this bank proceeds westwards.

Before opening the Bloomfield Mine, four prospect shafts were sunk to determine the position of the channel, and 1200 feet of drifting was done to test the value of the ground. No shafts have been sunk to prove the ground that it is proposed to work to the west, but the run of the channel is known because of drift tunnels and washing that has uncovered the bedrock at several places between here and Lake City. Towards the north, a covering of andesite masks the surface of the gravel, but it has been eroded through at sufficient places to allow an estimate of the probable gravel available. The gravel behind the face of this hydraulic pit is deep and there is over 50,000,000 cubic yards in a section of ground examined by me, less than 150 acres in area. From this bank to Lake City if the channel maintains the same shape as it has every indication of doing, the quantity of gravel would be over 150,000,000 cubic yards.

Mr. Waggoner has computed it as 172,000,000 to 195,000,000. From the main pit of the Bloomfield Hydraulic the amount excavated was 29,000,000 as given in Ex. Doc. 267, p. 84, but since that time another 11,000,000 was worked and the debris was stored in the pit itself, the water flowing over a debris dam and down the tunnel to Humbug Creek. The pit therefore represents an excavation of 40,000,000 cubic yards, less 11,000,000 stored in it and the 50,000,000 cubic yards of new gravel mentioned above would constitute a mine greater than that already excavated.

The Malakoff shaft was sunk to bedrock in 1922 and for a depth of 110 feet it showed 71 cents per cubic yard. This is close to the bank of gravel which is to be worked. No. 1 shaft was sunk 207 feet and the bottom 135 feet showed 41 cents per cubic yard.

Method of Attack.

To work this block of gravel it would be necessary to drive a new tunnel 4800 feet long in a northerly direction from the mouth of Humbug tunnel. This would give $4\frac{1}{2}$ per cent grade to the bottom of the channel. A shorter branch tunnel might be driven from the present tunnel, but this would not serve for long. In any case tunneling is

necessary to enable systematic mining to continue, and it would be done while the dam is being built.

Humbug Creek discharges into the South Yuba about $1\frac{1}{2}$ miles above the damsite called Norton's Cañon, and about 15 miles above the damsite at Shady Creek or Jones Bar. Because of the large amount of storage needed for this Lake City-Bloomfield gravel the plan first contemplated required a dam at Norton's Cañon built to a height of 290 feet, giving 68,000,000 cubic yards of storage and before 20 years elapsed a second dam would have been needed at the lower site at Jones Bar. Preliminary estimates from surveys in 1926 have shown that storage can be obtained more reasonably at the Narrows on the Main Yuba River, see Table II, page 16.

A study of the contour map shows that it would be feasible to attack other portions of this gravel from the South Yuba side if subsequent developments warrant doing so, but the western end at Badger Hill would be attacked from the Middle Yuba side.

Yield Expected.

Using half the water available on this ridge, 650,000 M. I. D., a duty of 4 would give 2,600,000 cubic yards for the average season's work. This at 10 cents would produce \$260,000.

Other Mines in the Bloomfield-Lake City Area.

In addition to the Bloomfield there were several other diggings or mines that produced gold from this vicinity all sending their debris to the South Yuba; the Brockmeyer, Paine diggings, Sherwood diggings, Dutch Boys diggings. It is improbable that there will be enough water to enable these diggings to be worked as separate concerns until the industry has had time to establish itself.

Just west of Lake City, and about 2 miles west of the Bloomfield Hydraulic Mine is the Union Hydraulic Pit. This discharged debris into Spring Creek, which empties into the South Yuba about five miles below Humbug Creek. Further west there begins a continuous series of mine pits that extend from North Columbia to Badger Hill. The first of these was known as the Consolidated Mine, as it was a consolidation of many small claims. This and the Union Hydraulic both drained into Spring Creek and in all probability future working would be done by sending the debris into the South Yuba.

Other Mines That Discharge Into the South Yuba.

SAILOR FLAT AND BLUE TENT.

An enormous quantity has been worked here, estimated at 15,000,000 cubic yards (see Doc. 267, pp. 84 and 89) and a very large amount remains, given as 30,000,000 to 60,000,000 cubic yards but there are many reasons which combine to make it improbable that any of this will be touched except a small amount of bottom gravel on the Blue Tent ground. The bedrock dips away from the river making it difficult to follow up with rockcuts and drainage tunnels and the main banks are remarkable in showing a large proportion of tuffs, fine sand and grit which would not be expected to be gold bearing. This material washed easily giving a duty said to be 10 cubic yards to the

miner's inch of water. The proportion of true hydraulic gravel below this is probably small. It is not visible, being covered by slides of material from above. Work had already been carried up to the cover of andesite and this would further reduce the value of the returns.

Larson's estimate for the gravel workable at Sailor Flat is 4,840,000 cubic yards* it being limited to this amount because of the large amount of barren material in the banks.

At the Blue Tent (Gopher Hill Pit) there is some bottom gravel partly occupied by the ruins of the old town and this looks to be good hydraulic gravel. This bank varies up to 160 feet high and contains over 2,000,000 cubic yards. Behind this, at the Enterprise Mine a considerable amount of work was done on material similar to that at Sailor Flat.

W. H. Pettee in Whitney (p. 414) says that 632,533 cubic yards washed in 1876-77 yielded 12.6 cents per cubic yard at Gopher Hill. In 1878, 501,028 cubic yards yielded 14 cents to the cubic yard at Gopher Hill. In the same year at the "Blue Lead" (same company's ground) 235,703 cubic yards yielded 7 cents per cubic yard. At the Enterprise pit of the same company 1,398,963 cubic yards of fine loose sandy material was washed in 1876-77 for a yield of 2.06 cents per cubic yard, barely enough to cover expenses.

RELIEF HILL.

About three miles east of North Bloomfield, on the North Bank of the South Yuba, is Relief Hill where 6,000,000 cubic yards is estimated as having been washed and from 5,000,000 to 15,000,000 available. Owners of ground here estimate there is 30,000,000 cubic yards available to the southwest and west of the old workings. A duty of 3 to 4 was easily obtained as there was plenty of grade. There are two ditches that give a short local water season of 1200 miner's inches. Some extra water can be purchased from the Bloomfield Company's ditch. Ex. Doc. No. 267, p. 88, says that the Eureka Lake Company's holdings here did not pay. The other ground was worked for many years by a group of miners with success, though the returns are not known. After being enjoined they continued to work illegally from time to time.

After injunctions considerable drifting was done. Exact returns are not known but are reported as \$30,000 to \$40,000 per year (see Lindgren p. 140). The gravel appears to have the general character of that at Omega and at Bloomfield, and should produce 9 to 13 cents per cubic yard where not drifted. The owners expect very much higher results. The bulk of the debris could be retained in the cañon and only the fines need be sent down the river.

Rate of Work Possible.

1200 M. I. for 4 months=about 120,000 M. I. D. for the season. With a duty of $3\frac{1}{2}$ this would treat 420,000 cubic yards. At 9 cents per cubic yard this would yield \$37,800.

If results equal to this be obtained, this ground would pay for the development of a water supply to prolong the season.

*See Ex. Doc. 98, pp. 108 and 109.

WASHINGTON.

Four miles further up the river there is a flat of unworked secondary gravel on the south side of the river, which is being prospected by the Washington Mining and Development Company. There is about 120 acres covered by gravel 35 feet deep or more. This has been tested by four shafts, which showed from 8 to 18 feet of bouldery gravel at the bottom, and ordinary river gravel above. The latter carried 8 to 12 cents per cubic yard and the bouldery gravel was richer, but very variable.

When drifting, a test on 46 carloads showed that the bottom gravel carried \$1.42 per cubic yard before discarding the boulders. 69 carloads from another portion of the property showed \$2.28 per cubic yard. A shallow gravel like this can be hydraulicked with good profit, but being alongside the river a dam must be provided on the river itself at some place lower down as at Norton's Cañon. The company has water rights on Scotchman's Creek and a ditch that conveys water used for ground sluicing. This can readily be made to carry 800 miner's inches.

Rate of Work and Yield Expected.

$800 \times 26 \times 7 = 145,600$ M. I. D. This gives 145,600 cubic yards for the season. Half of this at 15 cents and half at 50 cents would give \$47,320 for the season. The richer gravel on the bedrock and the gold from crevices in the bedrock may augment this figure considerably, but with these secondary gravels it is impossible to forecast what may be obtained owing to their spotty nature.

OMEGA.

This mine is about nine miles in a direct line east of North Bloomfield and is on the south side of the river. From it can be seen Alpha and other points where gravel has been worked, then Relief Hill and behind that, Bloomfield, these places marking the track of the old river that laid down these gravels. Omega is well known as having gravel that gave good profits, it being easy to move and regular in gold contents, averaging $13\frac{1}{2}$ cents for the whole bank. About 13,000,000 cubic yards have been mined and an additional 24,000,000 may be mined before the overburden of andesite will give trouble. If the gravel maintains its previous record for regularity of returns the whole of this will pay under the new conditions. The company possesses its own ditch that brings 5000 miner's inches from the South Yuba, also another ditch bringing 1200 miner's inches from Diamond Creek. The latter has been renewed this year and the former is being repaired. There is about nine miles of timber fluming (6 ft. x 4 ft.) alongside the river at the head of the larger ditch.

5000 M. I. for 6 months of 26 piping days = 780,000 M. I. D.

1200 M. I. for 4 months of 26 piping days = 124,800 M. I. D.

Total water for season ----- 904,800 M. I. D.

In 1880 these ditches supplied a total of 358,000 M. I. D. With a duty of 3 this would treat 1,074,000 cubic yards for the season. At 13 cents this would yield \$139,620. These are the figures used in Table on p. 71.

This rate of work would soon be attained if the ditches are cleaned out after the timber fluming has been repaired. About 3 miles of this fluming was repaired this summer ready to hydraulic. The figures indicate that the rate of work done in 1880 may be exceeded.

Mines That Would Discharge Into the Middle Yuba.

At the west end of the area described on p. 72, there were several mines that discharged into Shady Creek and its tributaries. This creek joins the South Yuba about 10 miles below Spring Creek. It has not sufficient fall to clear itself from the large amount of debris discharged into it and this very materially delayed work in the mines above.

A tunnel 12,000 feet long could be driven to tap these gravels from the South Yuba and give good grade, but 7,800 feet of driving would do the same work from Grizzly Creek, a tributary of Middle Yuba. Two shorter tunnels could also be driven from Grizzly Creek to tap the Patterson gravels. Therefore, a dam site was surveyed near Freeman's Bridge on the Middle Yuba for gravels between North Columbia and Paterson's or Badger Hill.

The site for the dam is a good one and gives impounding capacity more reasonably than any other site on the Middle Yuba. An alternative site was examined below Emory Ford or Emory Flat. A dam there would catch this gravel but the rock at the site is heavily jointed. Therefore, it is preferable to go four miles lower down to Freeman's where there is not this disadvantage, and where storage would be developed at less cost.*

The gravel that would be washed from this western end was formerly worked by a number of mines known as the Central, Consolidated, Eureka Lake, Laird, Farrel, Western, McCarty's, Patterson, Badger Hill.

The quantity of gravel remaining is readily calculated from the contours of the gravel surface and the contours of the bedrock in which it lies.

Leaving rim gravel out of account I calculated 442,000,000 cubic yards here that will be readily accessible when tunnels are driven from Grizzley Creek. Mr. Waggoner in a detailed examination estimated that 627,000,000 cubic yards are available. Mr. C. H. Munro indicates that attention would be chiefly directed to the central portion of the channel that he estimates contains 275,000,000 cubic yards.

The gravel already worked from these areas was top gravel, most of it light and not of great value; bedrock has not been reached, except at Badger Hill. Records of production are fragmentary as there has been no obligation imposed on owners to record their returns.

* Written before estimates of costs were obtained for dams on these sites and before agreement was reached for storage in the proposed dam at the Narrows on the Main Yuba River.

Table of Yields.

Mines	Cubic yards	Value per cubic yard	Yield	Year	Cost of water per M.I.D.
William Weigel.....	4,320,800	\$0.06 to \$0.08	\$345,663 10	1865-1868	\$0 25
McCartys.....	3,000,000	.0433	129,904 53		20
Grey's Diggins.....			(22,288)		
Eureka Lake Company.....		.041		1875	20
Consolidated.....	1,110,000	.031	35,776 72	1881	
Farrel.....	1,922,000	.050	96,115 52	1881	
Laird.....	1,120,000	.034	38,645 30	1881	
Consolidated.....	1,970,000	.044	86,800 00	1884	
Laird.....	346,000	.031	10,700 00	1884	
Totals.....	13,788,800		\$743,605 17		
Average.....		\$0.0535			

The table of yields given is compiled chiefly from data given in Mr. Hague's report. This shows a range of value from 3.1 to 8 cents and an average of 5.35. This was top gravel easily moved like that washed at North Bloomfield, Dutch Flat, You Bet and Gold Run, and similar to those other gravels in being of low value.

One shaft was sunk on the Consolidated ground. This showed a depth of 237 feet of gravel remaining and that it was originally 500 feet deep. Some drifting was done to determine the run of the channel which was found to be 600 feet wide (see Ex. Doc. 267, p. 88). The values from this work are not on record. A few miles further east the work done at North Bloomfield in 1887 showed that 1,591,730 cubic yards of gravel from the top 200 feet on the mine yielded 3.8 cents per cubic yard, and 702,200 cubic yards from the bottom 65 feet yielded 32.9 cents per cubic yard. The average for the 265 feet was 12.7 cents per cubic yard.

With yields of from 3.1 to 8 cents for the top gravel of the Columbia deposit we may reasonably expect something of the order of 9 to 12 cents from the gravel that lies below, at any rate in the central portion of the 627,000,000 cubic yards of gravel that remains. It is well to recall the general average of 9.8 cents obtained from 26,000,000 cubic yards mined at Bloomfield. Before work is commenced on this area it is probable that several trial shafts would be sunk to determine whether one portion of the ground is appreciably different from the rest. The expense of renovating the ditches and refitting the mines and for tunnelling would be considerable and if one portion of the gravel is richer than the rest it would be well to work that ground as early as possible.

Mr. C. H. Munro, Consulting Engineer for the River Mines Company, who has had extensive experience in hydraulic and dredge mining, has made a careful study and valuation of this deposit between North Bloomfield and Badger Hill. He writes as follows under dates of January 7 and January 31, 1927:

"The total length of channel considered is about 34,000 feet. The extensive drill prospecting work, coupled with mining operations, indicates 18,000 feet of channel, or 275,000,000 cubic yards, with an average recovery value of 10.5c per cubic yard, on the western portion."

"On the eastern, or North Bloomfield end, 5200 feet of channel have been worked to bedrock, with an average recovery of 9.06c for 29,870,000 cubic yards. Previous to the completion of the North Bloomfield bedrock tunnel short tunnels were run at elevations higher than the bottom of the channel to mine off the top gravels. In

some places these top gravels were mined to a width of 4800 feet. A large area of low grade ground was taken from the north and south rims in this area, which would otherwise not have been mined if the bedrock tunnel had been completed earlier. In future it will not be necessary to mine to the width as shown in the North Bloomfield pit but by selective mining or confining the operations to the pay channel a better recovery per cubic yard should be obtained than was secured from the former mining operations. It is, therefore, reasonable to assume that the eastern portion of the channel from the east end of the drilled area to the Malakoff pit, a distance of 16,000 feet, should give an average recovery of 10c per cubic yard for a total of 133,000,000 cubic yards."

"Summarizing the above figures, we have available selective yardage as follows:

<i>San Juan Channel</i>	<i>Length.</i>	<i>Cubic yards</i>	<i>Recovery value, cents</i>	<i>Total value</i>
Western portion -----	18,000 ft.	275,000,000	10.5	\$28,875,000
Eastern portion -----	16,000 ft.	133,000,000	10.0	13,300,000
Totals and averages-----	34,000 ft.	408,000,000	10.3	\$42,175,000

"When you consider the extent of drilling development over the 34,000 feet of channel and also that 5200 feet were mined to bedrock on the eastern end, the conclusions arrived at above are fair and reasonable."

"As soon as it is definitely decided that tailing storage space can be secured at a low cost, it is the intention of the River Mines Company to equip their large hydraulic property of San Juan Ridge for active mining operations."

At the above value, hydraulic mining would pay if the impounding is cheap and if the miner is assured that he may continue to mine upon complying with the regulations of the Commission.

With the assurance that there will be an adequate dam on the south and on the Middle Yuba it would pay to drive all the tunnels mentioned and to renovate ditches and flumes and refit the mines on this area. But unless there is the security that such work may be prosecuted regularly for many seasons it would be futile to expend the capital required. To recover this capital and earn interest upon it it will necessitate many years of work.

Rate of Work Possible.

On the Middle Yuba side of the ridge there would be available the other half of the water distributable by ditches belonging to the River Mines Company, viz:—650,000 M. I. D. for the year, plus "way water". The Consolidated, Farrel, and Laird diggings used 903,522 M. I. D. in 1881 according to Hague's report.

Additional water could be obtained from the Middle Yuba by excavating a ditch, but the cost would be large. Many ditch companies organized in the old days spent much money and were unable to return their capital to the shareholders; therefore, water that would entail building an entirely new ditch of considerable length is not included in this estimate. "Way water" will help considerably, however.

The duty obtainable on gravels at this end of the North Columbia deposit would be about the same as that obtained at the eastern end, viz, 4 cubic yards or more per miner's inch. 650,000 x 4 gives 2,600,000 cubic yards for the season. The same yardage would be obtained if some water from these ditches were diverted for work at Moore's Flat, Snow Point, or North San Juan, the only difference being that some of the gravel would be mined at these other places.

The above is a conservative estimate because "way water" or water picked up on the way would be considerable on the long run of ditches from Lake Bowman to the mines.

With a yearly yardage of 2,600,000 it will take a long time to work the gravel known to be available. It is, therefore, probable that means will be found for developing additional water and the above rate of work may be largely exceeded. In the meantime 2,600,000 cubic yards per annum is my estimate of what will be done provided that assistance be given through the erection of a large dam.

Other Districts on the Middle Yuba.

At Moore's Flat, the Blue Bank and Boston Mines worked their way well into the bank until they had to contend with a heavy cover of andesite. This finally came down as a large landslide and stopped hydraulic operations by smothering the rock cuts and boxes. To work behind this slide would necessitate sluicing away sufficient material to uncover the rock cuts and it is a matter of opinion whether this would pay. The Blue Bank was rich, and miners have assured me that it would pay to work, but I have not included it in the table of gravels available.

Water for work at Moore's Flat was drawn from ditches that supply water for the main area at North Columbia, viz, the River Mines Company ditches.

The yields for 1881 from Snow Point and Boston Mines were given by Mr. Hague as follows: Snow Point \$27,387.24, giving \$6,635.55 profit. At 4.9 yards to the M. I. D. this worked out at 11.3 cents per cubic yard and a cost of 8.5 cents. Boston yielded \$140,407.39 giving \$81,705.14 profit at 4.9 yards per M. I. D.; this gives 14.5 cents per cubic yard and a cost of 6.9 cents.

Some small areas of gravel are known on the Middle Yuba and its tributaries, and will be workable if a dam is provided at Freeman's for the North Columbia gravels. I did not examine them as they are widely separated.



ADMINISTRATIVE DIVISION.

WALTER W. BRADLEY, Deputy State Mineralogist.

Personnel.

Mr. E. A. Lowe of San Francisco has been appointed to the position of Librarian of the Bureau, vice Wm. E. Dolton, resigned.

New Publications.

During the quarterly period covered by this issue, the following Bureau publications have been made available for distribution:

Bulletin No. 97. 'California Mineral Production for 1925,' by Walter W. Bradley. 172 pages, illustrated with 9 half-tones and 10 line-cuts (maps and charts). Distributed without charge.

Summary of Operations, California Oil Fields, Vol. 12, Nos. 2 and 3 for August and September, 1926, respectively.

Commercial Mineral Notes: Nos. 45, 46, 47, November, 1926-January, 1927, (inc.). These 'notes' carry the lists of 'mineral deposits wanted' and 'minerals for sale' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'Mining in California.'

Mails and Files.

The Bureau maintains in addition to its correspondence file and the library, a mine report file which includes reports on some 7,500 mines and mineral properties in California.

During the period covered by this quarterly report, there were 1497 letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, and marketing of refined products.



DIVISION OF MINERALS AND STATISTICS.

Statistics, Museum, Laboratory.

WALTER W. BRADLEY, Deputy State Mineralogist.

CALIFORNIA'S MINERAL PRODUCTION IN 1926 MAINTAINS ADVANCE.**Estimate of 1926 Output.**

The total value of the mineral production of California for the year 1926, just closed, is conservatively estimated by the statistical division of the State Mining Bureau to have been approximately \$456,408,000. This is, in part, detailed in the tabulation below; but, as there are more than fifty mineral substances on California's commercial list, it is impracticable at this early date to obtain definite figures on other than the more important items. The blank report forms are being mailed to the operators in all mineral lines, and the date of publication of the final detailed and complete report will depend upon the promptness of their replies.

The estimated total of \$456,408,000 is an increase of approximately \$24,000,000 over the 1925 production, which in turn surpassed the previous record value of the year 1924. This increase is due mainly to petroleum, and in part also to cement and other structural materials. Although there was a decrease of approximately 8,000,000 barrels in the quantity of crude oil, the total value is higher by around \$25,000,000, owing to an advance in prices effective from March 11, 1926, and continuing throughout the year. Approximately 85% of the crude oil at present produced in California is above 20° Baumé, some of it testing as high as 50° B.; while the low-grade oil ranges down to 9° B. Current prices (January, 1926) range from 75c per barrel for 14°-20° crude in the San Joaquin Valley fields to \$2.74 for 43° crude in the Athens-Rosecrans-Dominguez group.

Receipts of bullion at the mint and smelters show a decrease in gold yield of about \$1,400,000 compared with 1925, the drop being chargeable to both lode mines and placers (except dredges, which maintained practically their same level). The drop in silver was due to closing the California Rand Silver mine and to decreased copper-ore shipments. The lesser copper output was due to Shasta County mainly, but in part to Plumas County. There was a slight increase in lead-ore shipments and about 50% increase in zinc, the latter including Shasta County and Santa Catalina Island. Although quicksilver prices advanced materially during 1926, closing the year at \$99 per flask, there was a decrease in the quantity produced, owing to closing down of the New Almaden and Cloverdale mines.

As building continued active throughout 1926, nearly all items of the structural group will show increased quantities and total values, especially cement, crushed rock, sand and gravel. Magnesite shipments decreased, due partly to maintenance of foreign importations and lower prices. There were no notable changes reported in the general status of the miscellaneous 'industrial' group nor among the salines.

The estimated quantities and values for 1926 are as follows

\$11,700,000	gold.
1,195,000	(1,920,000 fine oz.) silver.
4,400,000	(31,600,000 lb.) copper.
643,000	(7,750,000 lb.) lead.
1,202,000	(16,350,000 lb.) zinc.
540,000	(6,200 flasks) quicksilver.
25,000	(230 fine oz.) platinum.
360,000	other metals, including antimony, iron, manganese, tungsten.
355,000,000	(224,335,000 bbl.) petroleum.
16,000,000	(190,000,000 M. cu. ft.) natural gas.
27,000,000	(14,200,000 bbl.) cement.
17,500,000	crushed rock, sand and gravel.
7,500,000	brick and hollow building tile.
543,000	(47,000 tons, crude) magnesite.
3,000,000	other structural materials, including granite, et al.
5,500,000	miscellaneous 'industrial' minerals.
4,300,000	salines, including borates, potash, salt, et al.
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\$456,408,000	Total value.

MUSEUM.

The Museum of the State Mining Bureau possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America; and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Mining Bureau as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

LABORATORY.

FRANK SANBORN, Mineral Technologist.

Diamonds have been known to occur in California for many years; in fact, it was very soon after the discovery of gold that an article appeared in the American Journal of Science, published in September, 1849, mentioning the finding of a diamond in California. The sources or mode of occurrence of these diamonds are as yet unknown. Undoubtedly only a few of these precious stones passing through the sluice-boxes of the placer mines have been recovered, as but few systematic attempts to search for diamonds during gold-sluicing operations have been made.

A few months ago a small diamond was uncovered in this laboratory from a sample of black sand submitted from Siskiyou County. It was requested that this sample be tested for metals of the platinum group, and it was while concentrating the sample for subsequent treatment that the small gem was discovered. The suggestion was made to the sender of the sample that a diamond grease-board might prove to be of value, or at least interesting during the sluice-box clean-up.

Diamonds are heavy, having a specific gravity of 3.52; consequently, they will gather in the sluices or concentrate in the gold-pan. If these concentrates are passed over a board that has been coated with mutton tallow, the diamonds will adhere to the talloved board while the other material passes over it. The talloved board should be "jigged" or vibrated in such a way that the sand and gravel will work off, leaving any diamonds adhering to the tallow.

During the three-month period covered by this report, 1105 samples were received and determined at the Bureau's laboratory.



LIBRARY.

E. A. LOWE, Librarian.

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the State Mining Bureau contains some five thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, 'Mining in California' contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED.

Governmental.

U. S. Geological Survey :

Annual Report of the Director to the Secretary of the Interior for the Fiscal Year ending June 30, 1926.

Bulletin 784—Bibliography of North American Geology for 1923-24. By John M. Nickles.

Bulletin 785-C—Borate Deposits in the Kramer District, Kern County, California. B. L. F. Noble.

Bulletin 785-D—Note on a Colmanite Deposit near Shoshone, Cal., with a Sketch of the Geology of a part of Amargosa Valley. By L. F. Noble.

Bulletin 786-A—The Geology of the Ingomar Anticline, Treasure and Rosebud Counties, Montana. By K. C. Heald.

Bulletin 788-A—Topographic Instructions of the United States Geological Survey. By H. M. Frye.

Bulletin 788-B—Topographic Instructions of the United States Geological Survey. B. Triangulation. By E. M. Douglas.

Bulletin 788-C—Topographic Instructions of the United States Geological Survey. C. Transit Traverse. By E. M. Douglas.

Bulletin 788-D—Topographic Instructions of the United States Geological Survey. D. Leveling. By E. M. Douglas.

Bulletin 790-A—Pedestal Rocks Formed by Differential Erosion and Channel Erosion of the Rio Salado Socorro County, New Mexico. By Kirk Bryan.

Bulletin 790-B—The "Palouse Soil" Problem with an Account of Elephant Remains in Wind-borne Soil on the Columbia Plateau of Washington. By Kirk Bryan.

Professional Paper 147-C—American Tertiary Mollusks of the Genus *Clementia*. By W. P. Woodring.

- Professional Paper 137—The Fauna of the Ripley Formation on Coon Creek, Tennessee. By Bruce Wade.
- Water Supply Paper 530—Surface Water Supply of the United States, 1921, Part X, The Great Basin. Prepared in cooperation with the states of Idaho, Utah, Nevada, California and Oregon. By Nathan C. Grover.
- Water Supply Paper 553—Surface Water Supply of the United States, 1922, Part XII, North Pacific Slope Drainage Basins. By Nathan C. Grover.
- Water Supply Paper 554—Surface Water Supply of the United States, 1922, Part XII, North Pacific Slope Drainage Basins. By Nathan C. Grover.
- Water Supply Paper 555—Surface Water Supply of Hawaii, July 1, 1921, to June 30, 1922. By N. C. Grover.
- Water Supply Paper 559—Relations between Quality of Water and Industrial Development in the United States. By W. D. Collins.
- Water Supply Paper 564—Surface Water Supply of the United States. By Nathan C. Grover.
- Water Supply Paper 565—Surface Water Supply of the United States, 1923, Part V, Hudson Bay and Upper Mississippi River Basins.
- Water Supply Paper 580-B—Water Power and Irrigation in the Jefferson River Basin, Montana. By John F. Deed and Walter N. White.
- Water Supply Paper 592—Surface Water Supply of the United States in 1924, Part XII, North Pacific Slope Drainage Basins. By Nathan C. Grover.

U. S. Bureau of Mines:

- Bulletin 243—Diamond Drilling with Special Reference to Oil-Field Prospecting and Development.
- Bulletin 249—Manual of Testing Methods for Oil Shale and Shale Oil.
- Bulletin 250—Oil Field Emulsions.
- Bulletin 254—Smoke-Abatement Investigation at Salt Lake City, Utah.
- Bulletin 255—Investigation of the Preparation and Use of Lignite, 1918-1925.
- Bulletin 258—Suggestions for the Design of Electrical Accessories for Permissible Mining Equipment.
- Bulletin 264—Metal-Mine Accidents in the United States, 1924.
- Technical Paper 303—Utilization of Manganiferous Iron Ores. By T. L. Joseph, P. H. Royster and S. P. Kinney.
- Technical Paper 379—Strength of Ore and Top Rock in Red Iron-Ore Mines of the Birmingham District, Alabama. By W. R. Crane.
- Technical Paper 390—Occurrence, Distribution, and Significance of Alkali Cyanides in the Iron Blast Furnace. By S. P. Kinney and E. W. Guernsey.
- Technical Paper 392—Accidents in the Petroleum Industry of Oklahoma, 1915-1924. By H. C. Fowler.
- Technical Paper 396—Low Temperature Carbonization of Coal. By A. C. Fieldner.
- Technical Paper 397—Composition of Materials from Various Elevations in an Iron Blast Furnace. By S. P. Kinney.
- Technical Paper 400—Accidents Due to Explosives in Metal Mines of the Southwest as Shown by Records in Arizona. By E. D. Gardner.
- Technical Paper 402—Safety Rules for Installing and Using Electrical Equipment in Coal Mines, Sponsored by the U. S. Bureau of Mines and American Mining Congress.
- Technical Paper 406—Production of Explosives in the United States During the Calendar Year 1925.
- Technical Paper 408—Coke Oven Accidents in the United States During Calendar Year 1925. By William W. Adams.

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- Salt, Bromine, and Calcium Chloride in 1925. By A. T. Coons.
- Secondary Metals in 1925. By J. P. Dunlop.
- Lime in 1925. By A. T. Coons.
- Natural Gas in 1925. By G. R. Hopkins.
- Phosphate Rock in 1925. By W. M. Weigel and B. H. Stoddard.
- Platinum and Allied Metals in 1925. By James M. Hill.
- Tin in 1925. By J. R. Furness.
- Iron Ore, Pig Iron and Steel in 1925. By Hubert W. Davis.
- Chromite in 1925. By J. W. Furness.
- Lead and Zinc Pigments and Salts in 1925. By J. A. Stader and A. Stoll.
- Manganese and Manganiferous Ores in 1925. By J. W. Furness.

Lead in 1925. Smelter Report. By J. A. Stader and A. Stoll.
 Gold, Silver, and Copper in South Dakota and Wyoming in 1925. By Charles W. Henderson.
 Gold, Silver, and Copper in South Dakota and Wyoming in 1924. By C. W. Henderson.
 Gold, Silver, Copper, Lead, and Zinc in Colorado in 1924. By C. W. Henderson.
 Gold, Silver, Copper, Lead, and Zinc in New Mexico and Texas in 1924. By C. W. Henderson.
 Mercury in 1925. By J. W. Furness.
 Asphalt and Related Bitumens in 1925. By G. R. Hopkins and A. B. Coons.
 Feldspar in 1925. By Jefferson Middleton.
 Graphite in 1925. By Jefferson Middleton.
 Carbon Black Produced from Natural Gas in 1925. By G. R. Hopkins.
 Asbestos in 1925. By Blanche H. Stoddard.
 Slate in 1925. By A. T. Coons.
 Magnesium and its Compounds in 1925. By J. M. Hill.
 Barite and Barium Products in 1925. By A. Stoll and R. M. Sautmyer.
 Clay in 1925. By Jefferson Middleton.
 Gypsum in 1925. By Jefferson Middleton.
 Abrasive Materials in 1925. By Frank J. Katz.
 Mica in 1925. By W. M. Myers and Blanche H. Stoddard.
 Natural Gas-Gasoline in 1925. By G. R. Hopkins.
 Talc and Soapstone in 1925. By Blanche H. Stoddard.
 Arsenic in 1925. By V. C. Heikes.
 Bauxite and Aluminum in 1925. By James M. Hill.
 Gold, Silver, Copper, Lead, and Zinc in the Eastern States in 1925. By J. P. Dunlop.
 Petroleum in 1924. By G. B. Richardson and A. B. Coons.
 Antimony in 1925. By J. W. Furness.
 Annual Report of the Director of the Bureau of Mines, year ending June 30, 1926.
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 Index of Bureau of Mines Publications.
 Bureau of Mines Safety Labels. By L. C. Ilsley.

Reports of Investigations.

Serial No. 2789—Charging Explosives in Drill Holes of Drift Rounds in Metal Mines. By E. D. Gardner.
 Serial No. 2790—The Blasting of Hanging Ore Columns in Chutes and Drawing Raises. By E. D. Gardner.
 Serial No. 2791—Explosives used in December, 1926, Including Preliminary Figures for the Year 1926. By W. W. Adams.
 Serial No. 2792—Coal Mine Fatalities in December, 1926, and Preliminary Figures for the Year 1926. By W. W. Adams.

Information Circulars.

Circular No. 6015—The Motor Fuel Situation. By A. J. Kraemer.
 Circular No. 6016—Survey of Petroleum Pipe Lines and Storage Capacity for Crude Oil and Refined Products. By G. R. Hopkins and A. B. Coons.
 Circular No. 6017—Railroad Fuel Oil Consumption. By E. B. Swanson.
 Circular No. 6018—The Tin Situation from a Domestic Standpoint. By J. W. Furness.
 Circular No. 6019—Consumption of Tin in the United States, 1925. By J. W. Furness.
 U. S. Army: Annual Report of the Chief of Engineers, Parts 1 and 2, 1926.
 Director of the Mint: Annual Report for 1926. The Production of the Precious Metals.
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 Alabama Geological Survey:
 Report of Progress, 1923-26. By Eugene Allen Smith, Ph.D.
 Special Report No. 14, 1926. The Geology of Alabama. By G. I. Adams, C. Butts, L. W. Stephenson, and W. Cooks.

Idaho Bureau of Mines and Geology :

Geology and Ore Deposits of Boundary County, Idaho. By Virgil R. D. Kukham and Ernest W. Ellis.

Ground Water for Municipal Supply at St. Maries, Idaho. By Virgil R. D. Kukham.

Illinois State Geological Survey :

List of Publications on the Geology of Illinois with Appended Index.

Illinois Petroleum, No. 6, Dec. 4, 1926.

Kansas State Inspector of Oils: Annual Report to the Governor of Kansas.

Kentucky Geological Survey: Series No. VI, Pamphlet No. XI. A Bibliography of the several Books, Reports, Papers, and Maps by Willard Rouse Jillson.

Minnesota Chats :

Vol. 7, No. 92, October, 1926.

Vol. 7, No. 93.

Missouri Bureau of Geology and Mines: Vol. XIX, Second Series. The Geology of Vernon County.

Nevada State Inspector of Mines: Biennial Report, 1925-26. By A. J. Stinson.

New York Public Library: New Technical Books. Vol. II, No. 3.

North Carolina Department of Conservation and Development:

Biennial Report of the Director, 1925-26. By Wade H. Phillips.

Economic Paper No. 57. The Economic Development of the Furniture Industry of the South and Its Future Dependence Upon Forestry. By C. F. Korstian.

Oklahoma Geological Survey :

Circular 9—The Sycamore Limestone. By C. L. Cooper.

Circular 13—The Permian of Western Oklahoma and the Panhandle of Texas. By Chas. N. Gould and Frank E. Lewis.

Bulletin 41—The Upper Paleozoic Rocks of Oklahoma.

West Virginia Geological Survey: Mercer, Monroe and Summers. By David B. Reger and Paul H. Price.

California Bureau of Labor Statistics: Twenty-second Biennial Report, 1925-26. By Walter G. Mathewson.

California Fish and Game Commission: Twenty-ninth Biennial Report, 1924-26.

California Industrial Accident Commission: Report, July 1, 1925, to June 30, 1926.

California State Library: Vol. 21, No. 4, October, 1926. News Notes of California Libraries. Annual Statistics.

Argentina Republica, Direccion General de Minas, Geologia, e Hidrologia :

Publicacion 17—Sobre el Contenido de Azufre-en-el Yeso de Transicion de la Sierra de Vaca Muerta. By L. R. Catalano.

Publicacion 18—La Presencia del niquel en algunos petroleos, Rafaelita y el supuesto carbon de Malarque. By H. Corti.

Publicacion 19—Los Hoyos del Campo Cielo y el Meteorito. By J. J. Nagera.

Publicacion 20—Informe Sobre las posibilidades existentes para el Aprovechamiento de agua en Puerto Camarones. By Anselmo Winhausen.

Publicacion 21—

I. Sobre las Minas de Cobra de Famatina.

II. Establecimiento Metalurgico de Sta. Florentina. By N. A. Lammefors y S. Wassman.

Publicacion 22—Yacimientos Cao Knicos del Valle de los Savces. By L. R. Catalano.

Australian Institute of Mining and Metallurgy :

Proceedings Nos. 60 and 61.

Proceeding 62, New Series, June 30, 1926.

Proceeding 63, New Series, September 30, 1926.

Australian Museum :

Records, Vol. XV, No. 2.

Records, Vol. XV, No. 3.

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Canada Department of Mines :

Report for the Fiscal Year Ending March 31, 1926.

Biological Series No. 12—Nov. 9, 1926. List of Quarternary and Tertiary Diatomageal from Deposits of South Canada. By C. S. Boyes.

Memoir 149, No. 130 Geological Series—Placer and Vein Gold in Deposits of Barkerville, Cariboo District, British Columbia. By W. A. Johnston and W. L. Uglow.

Memoir 150, No. 131 Geological Series—Whitehorse District, Yukon. By W. E. Cockfield and A. H. Bell.

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Investigations in Ore Dressing and Metallurgy, 1925.

Investigations of Mineral Resources and the Mining Industry, 1925.

Bituminous Sands of Northern Alberta, with Map Folio. By S. C. Ells.

Sodium Sulphate in Western Canada. By L. H. Cole.

Canadian Institute of Mining and Metallurgy:

Bulletin 175, November, 1926.

Bulletin 176.

Great Britain Geological Survey:

Vol. V—Special Report on the Mineral Resources of Great Britain. Iron Ores—the Hæmatities of the Forest of Dean and South Wales.

The Geology of the Country near Lewes. By H. J. O. White.

Manchuria Geological and Mining Review: No. 67, Dec. 1, 1926. Dr. H. Murakami and B. Toheida.

Mexico Secretaria de Industria, Comercio y Trabajo:

Boletin del Petroleo, Vol. XXII, No. 4. Tallares Graficos de la Nacion Mexico, 1926.

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Anuario de Estadistica Minera, 1924.

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Estados Unidos Mexicanos Estradistica Nacional.

New Zealand Department of Mines: Palæontological Bulletin 11—The Cretaceous and Tertiary Foraminifera of New Zealand. By F. Chapman.

Ontario Department of Mines:

Bulletin 58—Metal Production of Ontario for 9 Months of 1926. By W. R. Rogers and A. C. Young.

November Gold Bulletin.

Thirty-fifth Annual Report, Vol. XXXV, Part IV, 1925. By G. Vibert Douglas.

Thirty-fifth Annual Report, Vol. XXXV, Part V to VIII. By R. B. Harkness.

Thirty-fifth Annual Report, Vol. XXXV, Part III, 1926.

Philippine Journal of Science:

Vol. 31, No. 1, September, 1926.

Vol. 31, No. 3, November, 1926.

Vol. 31, No. 4, December, 1926.

Poland, Legation of: Production of Minerals, January 10, 1927.

Rio de Janiero: Archivos Museu Nacional, Vol. XXVI.

South Australia Department of Mines: Mining Review, No. 44, Half Year Ending June 30, 1926. By Hon. A. A. Kirkpatrick, M. L. C.

South Manchuria: The Geology and Mineral Resources of.

Transvaal Chamber of Mines: Notice of Ordinary Meeting.

Uruguay Instituto de Geologia y Perforaciones Montevideo: Boletin 8a—Julio de 1926. Nota sobre el pisco de Itarare y los sedimentos marinos del Rincon de Alonso. Pro. E. Terra Arocena.

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American Geographical Society:

The Geographical Review, Vol. XVI, 1926.

The Geographical Review, January, 1927.

Alabama, University of:

Bulletin 31—Analyses of Alabama Coals. By Charles Butts.

Bulletin 28—Index to the Mineral Resources of Alabama. By Walter B. Jones, Ph. D.

California, University of:

Skull and Skeletal Remains of a Ruminant of the Preptoceras-Euceratherium Group. By Chester Stock and E. L. Furlong.

Geology of the La Jolla Quadrangle, California. By Marcus A. Hanna.

Publications in Geological Sciences, Vol. XV, 1924-1926. By A. C. Lawson, and G. D. Louderback.

Publications in Geological Sciences, Vol. XVI, No. 5. The Domengine Horizons Middle Eocene of California. By B. L. Clark.

Publications in Geological Sciences, Vol. XVI, No. 6. Geology of Point Sur Quadrangle, California. By P. D. Trask.

Chile American Association, New York, 1926: Mutual Trade and Resources of Chile and the United States.

Missouri, University of, School of Mines and Metallurgy: Bulletin, 1927, Vol. 19, No. 2.

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Washington, University of, Engineering Experiment Station: Bulletin 18—The Clays and Shales of Washington, their Technology and Uses. By Hewitt Wilson.

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Bulletin 266—November, 1926.

Bulletin 267—December, 1926.

Bulletin 268—January, 1927.

Mining and Metallurgy Society of America:

Bulletin 187—January, 1927, Vol. XX, No. 1.

Bulletin 185.

Bulletin 186.

Mineralogical Society of America:

The American Mineralogist, Vol. 11, No. 12, Walter F. Hunt, Editor.

The American Mineralogist, Vol. 12, No. 2, February, 1927.

Society of Chemical Industry: Recent Developments in the Formation of Synthetic Fuel from Carbon Monoxide and Hydrogen.

Rensselaer Polytechnic Institute: No. 13, An Investigation of the Physical Properties of some Nickel-Iron Alloys of the Invar Group. By Eric Anders Blomquist.

Smithsonian Institute:

Annual Report, 1925.

Report on the International Exchange Service, 1926.

Western Society of Engineers: Journal, October, 1926; Vol. XXXI, No. 10.

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State Publications Received during September, 1926. Vol. 17, No. 9.

State Publications Received during September, 1926. Vol. 19, No. 11, November, 1926.

California Academy of Sciences:

Proceedings, Vol. II, Part 1, 1913-17.

Proceedings, Vol. II, Part 2, 1918-26.

Proceedings, Vol. XIV, 1924.

Proceedings, Vol. XVI, No. 1.

Proceedings, Vol. XVI, No. 2.

Proceedings, Vol. XVI, No. 3.

Proceedings, Vol. XVI, No. 4.

Economic Geology Series No. 2: Talc Deposits of Canada. By M. E. Wilson.
 Vol. XXI, No. 7, November, 1926.
 Vol. XXI, No. 8, December, 1926.
 Vol. XXII, January-February, 1927, No. 1 .

Books.

Pictorial History of the Lassen Volcano. By B. F. Loomis.

Maps.

Topographic Maps:

Burbank, California.	Los Angeles, California.
Corcoran, California.	Claremont, California.
Guernsey, California.	La Verne, California.
Lake View School, California.	La Crescenta, California.
Lindsay, California.	Hanford, California.
Tipton, California.	Van Nuys, California.
Waukena, California.	Mt. Lowe, California.
Westhaven, California.	Topango Canyon, California.
Woodville, California.	Puente, California.
Goshen, California.	Sierra Madre, California.
Beardstown, Illinois.	San Pedro Hills, California.
Black River Falls, Wisconsin.	Azusa, California.
Brookville, Pennsylvania.	Lemon Cove, California.
Fraser, Colorado.	Montezuma, Colorado.
Harrisburg, West Virginia.	Morattico, Virginia.
Island Pond, Vermont.	New Matamoras, Ohio-West Virginia.
Littleton, West Virginia-Pennsylvania.	Oregon, Missouri-Kansas.
McHenry, Illinois-Wisconsin.	Pittsfield, Illinois.
McMinnville, Oregon.	St. Joseph, Missouri-Kansas.
Lethent, California.	Tuscaloosa, Alabama.
Altadena, California.	Tuscumbia, Alabama.
La Habra, California.	Wauzeka, Wisconsin.
Reseda, California.	Wellsville, New York.
Glendale, California.	West Union, West Virginia.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

American Petroleum Institute, New York.
 Architect and Engineer, San Francisco.
 Arizona Mining Journal, Phoenix, Arizona.
 Asbestos, Philadelphia, Pennsylvania.
 Brick and Clay Record, Chicago.
 Bulletin, Union Oil Co., Los Angeles.
 California Journal of Development, San Francisco.
 Cement, Mill and Quarry, Chicago, Illinois.
 Chemical-Engineering and Mining Review, Melbourne, Australia.
 Engineering and Mining Journal-Press, New York.
 Explosives Engineer, Wilmington, Del.
 Financial Insurance News, Los Angeles, California.
 Graphite, Jersey City.
 Journal of Electricity and Western Industry, San Francisco.
 Metallurgical and Chemical Engineering, New York.
 Mine and Quarry, Chicago.
 Mining and Engineering Record, Vancouver, B. C.
 Mining and Oil Bulletin, Los Angeles.
 Oil Age, Los Angeles.
 Oil and Gas Journal, Tulsa, Oklahoma.
 Oil and Gas News, Kansas City.
 Oil News, Galesburg, Illinois.

Oildom, New York.
 Oil, Paint and Drug Reporter, New York.
 Oil Trade Journal, New York.
 Oil Weekly, Houston, Texas.
 Petroleum Age, New York.
 Petroleum Record, Los Angeles.
 Petroleum World, Los Angeles.
 Queensland Government Mining Journal, Brisbane, Australia.
 Rock Products, Chicago, Illinois.
 Safety News, Industrial Accident Commission, San Francisco.
 Salt Lake Mining Review, Salt Lake City, Utah.
 Southwest Builder and Contractor, Los Angeles.
 Standard Oil Bulletin, San Francisco.
 Stone, New York.
 The Record, Associated Oil Company, San Francisco.
 Through the Ages, Baltimore.

Newspapers.

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, Cal.
 Arkansas Oil and Mineral News, Hot Springs National Park (Arkansas).
 Barstow Printer, Barstow, Cal.
 Blythe Herald, Blythe, Cal.
 Bridgeport Chronicle-Union, Bridgeport, Mono Co., Cal.
 Calaveras Prospect, San Andreas, Cal.
 California Oil World, Los Angeles, Cal.
 Cloverdale Reveille, Cloverdale, Cal.
 Colusa Daily Sun, Colusa, Cal.
 Daily Commercial News, San Francisco, Cal.
 Daily Midway Driller, Taft, Cal.
 Del Norte Triplicate, Crescent City, Cal.
 Exeter Sun, Exeter, Cal.
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 Goldfield News, Goldfield, Nevada.
 Guerneville Times, Guerneville, Cal.
 Healdsburg Enterprise, Healdsburg, Cal.
 Humboldt Standard, Eureka, Cal.
 Inyo Independent, Independence, Cal.
 Inyo Register, Bishop, Cal.
 Ione Valley Echo, Ione, Cal.
 Lake County Bee, Lakeport, Cal.
 Mining and Financial Record, Denver, Colo.
 Mining Topics, San Francisco, Cal.
 Mountain Democrat, Placerville, Cal.
 Mountain Messenger, Downieville, Cal.
 Nevada Mining Press, Reno, Nevada.
 Oatman Mining News, Oatman, Arizona.
 Oregon Observer, Grants Pass, Oregon.
 Oroville Daily Register, Oroville, Cal.
 Petroleum Reporter, Taft, Cal.
 Placer Herald, Auburn, Cal.
 Plumas Independent, Quincy, Cal.
 Plumas National Bulletin, Quincy, Cal.
 Randsburg Times, Randsburg, Cal.
 San Diego News, San Diego, Cal.
 Shasta Courier, Redding, Cal.
 Siskiyou News, Yreka, Cal.
 Stockton Record, Stockton, Cal.
 Tuolumne Prospector, Tuolumne, Cal.
 Ventura Daily Post, Ventura, Cal.
 Weekly Trinity Journal, Weaverville, Cal.
 Western Sentinel, Etna Mills, Cal.

PRODUCERS AND CONSUMERS.

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of MINING IN CALIFORNIA, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes.'



EMPLOYMENT SERVICE.

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

The Bureau registers technical men, or those qualified for supervisory positions, and vacancies of like nature, only, as no attempt will be made to supply common mine and mill labor.

A list of current applications for positions and 'positions open' is carried in each issue. Notices are designated by a key number, and the name and address corresponding to any number will be supplied upon request, without delay or charge of any kind. If desired, recommendations may be filed with an application, but copies only should be sent to the Bureau, to avoid possible loss. Registration cards for the use of both prospective employers and employees may be obtained at any office of the Bureau upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded.

POSITIONS WANTED.

- 51-1 Examination and consulting work.
- 51-2 Store or cost accountant. Two and one-half years as clerk, correspondent and private secretary. Age 26. Married. References. Salary open.
- 51-3 Assayer or foreman. Assayer and superintendent various properties in South Dakota, Colorado, Montana, Alaska and Nevada. Age 59. Married. References. Salary open.
- 51-4 Mining or metallurgy, preferably in foreign country. University training in mining and metallurgy. Twelve years' experience in Alaska, California and Nevada. Speaks some French. Age 30. Married, but can travel. References. Salary open.



PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU.

During the past forty-four years, in carrying out the provisions of the organic act creating the California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the state, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the Bureau's offices in the Ferry Building, San Francisco; New Orpheum Building, Los Angeles; Chamber of Commerce Building, Sacramento; Santa Maria; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states, and foreign countries.

A catalog of all publications of the Bureau, from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the offices of the State Mining Bureau and enclosing the requisite amount in the case of publications that have a list price. The Bureau is authorized to receive only coin, stamps or money orders, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the State Mining Bureau.

REPORTS.

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks-----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks-----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks-----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. -----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	----

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	-----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.-----	\$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford-----	-----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford-----	-----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper-----	-----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper-----	.50
Mines and Mineral Resources, Del Norte, Humboldt, and Mendocino Counties, 59 pp., paper-----	.25
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper-----	-----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper-----	.35
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper-----	-----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou, and Trinity Counties, 974 pp., 275 illustrations, cloth-----	-----
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper-----	-----
**Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter, and Tehama Counties, 91 pp., paper-----	-----
Mines and Mineral Resources, El Dorado, Placer, Sacramento, and Yuba Counties, 198 pp., paper-----	.65
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties, 183 pp., paper-----	.65
Mines and Mineral Resources, Los Angeles, Orange, and Riverside Counties, 136 pp., paper-----	.50
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper-----	-----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	-----
Chapters of the State Mineralogist's Report, Biennial Period 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper-----	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper-----	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper-----	.50
Seventeenth Report of the State Mineralogist, 1920, Mining in California during 1920, Fletcher Hamilton: 562 pp., 71 illustrations, cloth-----	1.75

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

Price

Eighteenth Report of the State Mineralogist, 1922, Mining in California, Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, May, June, July, August, September, October, November, December, 1922-----	Free
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 -----	Free
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy-----	\$0.25
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange counties-----	.25
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura counties-----	.25
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego counties -----	.25
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara counties-----	.25
Subscription, \$1.00 in advance (by calendar year, only).	
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz counties -----	.25
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial counties -----	.25
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties--	.25
October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties	.25
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume) -----	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, June, **July, **August, **September, **October, November, **December, 1919 -----	Free
January, February, March, April, **May, June, July, **August, September, October, November, December, 1920-----	Free
January, **February, **March, **April, May, June, **July, August, **September, **October, **November, **December, 1921-----	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1922-----	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1923-----	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1924-----	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1925-----	Free
January, February, March, April, May, June, July, August, September, 1926--	Free

BULLETINS.

Asterisks (**) indicate the publication is out of print.

**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations-----	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations-----	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps--	----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)-----	----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations -----	-----
Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations-----	\$0.50
**Bulletin No. 7. Mineral Production of California, by Counties for the year 1894, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 8. Mineral Production of California, by Counties for the year 1895, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations-----	-----
**Bulletin No. 10. A bibliography Relating to the Geology, Palæontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp. -----	-----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations -----	-----
**Bulletin No. 12. Mineral Production of California, by Counties for 1896, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 13. Mineral Production of California, by Counties for 1897, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 14. Mineral Production of California, by Counties for 1898, by Charles G. Yale-----	-----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899 -----	-----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations-----	-----
**Bulletin No. 17. Mineral Production of California, by Counties for 1899, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations-----	-----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps-----	-----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899-----	-----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet-----	-----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet-----	-----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, and 9 maps-----	.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps-----	-----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 26. Mineral Production of California for the past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet-----	-----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps-----	-----
**Bulletin No. 28. Mineral Production of California, for 1902, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet-----	-----
**Bulletin No. 30. Bibliography Relating to the Geology, Palæontology, and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.-----	-----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet-----	-----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps-----	-----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet-----	-----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet-----	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California-----	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905, 120 pp., 66 illustrations, 3 maps-----	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations-----	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map-----	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet-----	----
**Bulletin No. 41. Mines and Minerals of California, for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps-----	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps-----	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.-----	----
Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.-----	\$0.30
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 48. Mineral Production of California for Twenty Years. 1906, by Charles G. Yale-----	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.-----	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman, 366 pp., 74 illustrations. (Revised edition.)-----	1.00
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker, 62 pp.-----	----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker. 78 pp.-----	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations and 10 maps-----	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 60. Mineral Production for 1909, County Maps and Mining Laws of California, by D. H. Walker. 94 pp.-----	----
**Bulletin No. 61. Mineral Production of California, by Counties for 1910, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker, 1910. Tabulated sheet-----	----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps-----	----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.---	----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.---	----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp. -----	----
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp. -----	----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.-----	----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]-----	----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.-----	----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp., 4 illustrations-----	----
Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.-----	\$0.25
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the fiscal year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations-----	----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations-----	Free
**Bulletin No. 75. United States and California Mining Laws, 1917. 115 pp., paper -----	----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring, 1918. 248 pp., 51 illustrations, 5 maps, paper-----	.50
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880-1917, by E. S. Boalich. 44 pp., paper-----	Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley, 1918. 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth-----	1.50
Bulletin No. 79. Magnesite in California, by Walter W. Bradley, 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth-----	1.00
Bulletin No. 80. Tungsten, Molybdenum and Vanadium in California. (In preparation.) -----	----
Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)--	----
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1916-1917, by R. P. McLaughlin, 1918. 412 pp., 31 illustrations, cloth-----	----
Bulletin No. 83. California Mineral Production for 1917, with County Maps, by Walter W. Bradley. 179 pp., paper-----	Free
**Bulletin No. 84. Third Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1917-1918, by R. P. McLaughlin, 1918. 617 pp., 28 illustrations, cloth-----	----
**Bulletin No. 85. Platinum and Allied Metals in California, by C. A. Logan, 1919. 10 photographs, 4 plates, 120 pp., paper-----	----
Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley, 1919. 212 pp., paper-----	Free
**Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello, 1920. 124 pp., paper-----	----
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley, 1920. 204 pp., paper-----	Free
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leek, 1921. 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth-----	----
Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley, 1921. 218 pp., paper-----	Free
Bulletin No. 91. Minerals of California, by Arthur S. Eakle, 1923, 328 pp., cloth -----	1.00

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
Bulletin No. 92. Gold Placers of California, by Chas. S. Haley, 1923. 167 pp., 36 photographs and 7 plates (colored and line cuts, also geologic map), cloth -----	\$1.50
Extra copies of the Geologic Map (in 4 colors)-----	.50
Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley, 1923, 188 pp., paper-----	Free
Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley, 1924, 162 pp., paper-----	Free
Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin, 1925. 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth-----	2.00
Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley, 1925. 173 pp., paper-----	Free
Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley, 1926. 172 pp., paper-----	Free

PRELIMINARY REPORTS.

Asterisks (**) indicate the publication is out of print.

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin. 4 pp.-----	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp.-----	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.-----	Free
Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper-----	Free
Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper--	Free
**Preliminary Report No. 6. A Review of Mining in California During 1919. Fletcher Hamilton, 1920. 43 pp. Paper-----	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper-----	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. Fletcher Hamilton, 1922. 68 pp. Paper-----	----

MISCELLANEOUS PUBLICATIONS.

Asterisks (**) indicate the publication is out of print.

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.-----	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.-----	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.-----	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.-----	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.-----	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.-----	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894-----	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper-----	----
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper-----	Free
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 -----	Free

MAPS.

Register of Mines With Maps.

Asterisks (**) indicate out of print.

	Price
**Register of Mines, with Map, Amador County -----	----
**Register of Mines, with Map, Butte County -----	----
**Register of Mines, with Map, Calaveras County -----	----
**Register of Mines, with Map, El Dorado County -----	----
**Register of Mines, with Map, Inyo County -----	----
**Register of Mines, with Map, Kern County -----	----
**Register of Mines, with Map, Lake County -----	----
**Register of Mines, with Map, Mariposa County -----	----
**Register of Mines, with Map, Nevada County -----	----
**Register of Mines, with Map, Placer County -----	----
**Register of Mines, with Map, Plumas County -----	----
**Register of Mines, with Map, San Bernardino County -----	----
**Register of Mines, with Map, San Diego County -----	----
Register of Mines, with Map, Santa Barbara County (1906) -----	\$0.25
**Register of Mines, with Map, Shasta County -----	----
**Register of Mines, with Map, Sierra County -----	----
**Register of Mines, with Map, Siskiyou County -----	----
**Register of Mines, with Map, Trinity County -----	----
**Register of Mines, with Map, Tuolumne County -----	----
Register of Mines, with Map, Yuba County (1905) -----	.25
Register of Oil Wells, with Map, Los Angeles City (1906) -----	.35

OTHER MAPS.

Asterisks (**) indicate the publication is out of print.

**Map of California, Showing Mineral Deposits (50 x 60 in.) -----	----
**Map of Forest Reserves in California -----	----
**Mineral and Relief Map of California -----	----
**Map of El Dorado County, Showing Boundaries, National Forests -----	----
**Map of Madera County, Showing Boundaries, National Forests -----	----
**Map of Placer County, Showing Boundaries, National Forests -----	----
**Map of Shasta County, Showing Boundaries, National Forests -----	----
**Map of Sierra County, Showing Boundaries, National Forests -----	----
**Map of Siskiyou County, Showing Boundaries, National Forests -----	----
**Map of Tuolumne County, Showing Boundaries, National Forests -----	----
**Map of Mother Lode Region -----	----
**Map of Desert Region of Southern California -----	----
Map of Minaret District, Madera County -----	.20
Map of Copper Deposits in California -----	.05
**Map of Calaveras County -----	----
**Map of Plumas County -----	----
**Map of Trinity County -----	----
**Map of Tuolumne County -----	----
Geological Map of Inyo County. Scale 1 inch equals 4 miles -----	.60
Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin -----	.25
**Geographical Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted -----	----
Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels. In 4 colors -----	.50

OIL FIELD MAPS.

Price

These maps are revised from time to time as development work advances and ownerships change.

Map No. 1—Sargent, Santa Clara County-----	\$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos-----	.75
Map No. 3—Santa Maria, including Casmalia and Lompoc-----	.75
Map No. 4—Whittier-Fullerton, including Olinda, Brea Canyon, Puente Hills, East Coyote and Richfield-----	.75
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello -----	.75
Map No. 6—Salt Lake, Los Angeles County-----	.75
Map No. 7—Sunset and San Emido and Kern County-----	.75
Map No. 8—South Midway and Buena Vista Hills, Kern County-----	.75
Map No. 9—North Midway and McKittrick, Kern County-----	.75
Map No. 10—Belridge and McKittrick, Kern County-----	.75
Map No. 11—Lost Hills and North Belridge, Kern County-----	.75
Map No. 12—Devils Den, Kern County-----	.75
Map No. 13—Kern River, Kern County-----	.75
Map No. 14—Coalinga, Fresno County-----	1.00
Map No. 15—Elk Hills, Kern County-----	.75
Map No. 16—Ventura-Ojai, Ventura County-----	.75
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County-----	.75
Map No. 18—Piru-Simi-Newhall Oil Fields-----	.75
Map No. 19—Arroyo Grande, San Luis Obispo County-----	.75
Map No. 20—Long Beach Oil Field-----	1.25
Map No. 21—Portion of District 4, Showing Boundaries of Oil Fields, Kern and Kings counties-----	.75
Map No. 22—Portion of District 3, Showing Oil Fields, Santa Barbara County -----	.75
Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County -----	.75
Map No. 24—Portion of District 1, Showing Boundaries of Oil Fields, Los Angeles and Orange counties-----	.75
Map No. 26—Huntington Beach Oil Field-----	.75
Map No. 27—Santa Fe Springs Oil Field-----	.75
Map No. 28—Torrance, Los Angeles County-----	.75
Map No. 29—Dominguez, Los Angeles County-----	.75
Map No. 30—Rosecrans, Los Angeles County-----	.75
Map No. 31—Inglewood, Los Angeles County-----	.75
Map No. 32—Seal Beach, Los Angeles and Orange Counties-----	.75

DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

THE STATE MINING BUREAU
CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE
MINERAL RESOURCES OF CALI-
FORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the state, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the State Mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily.

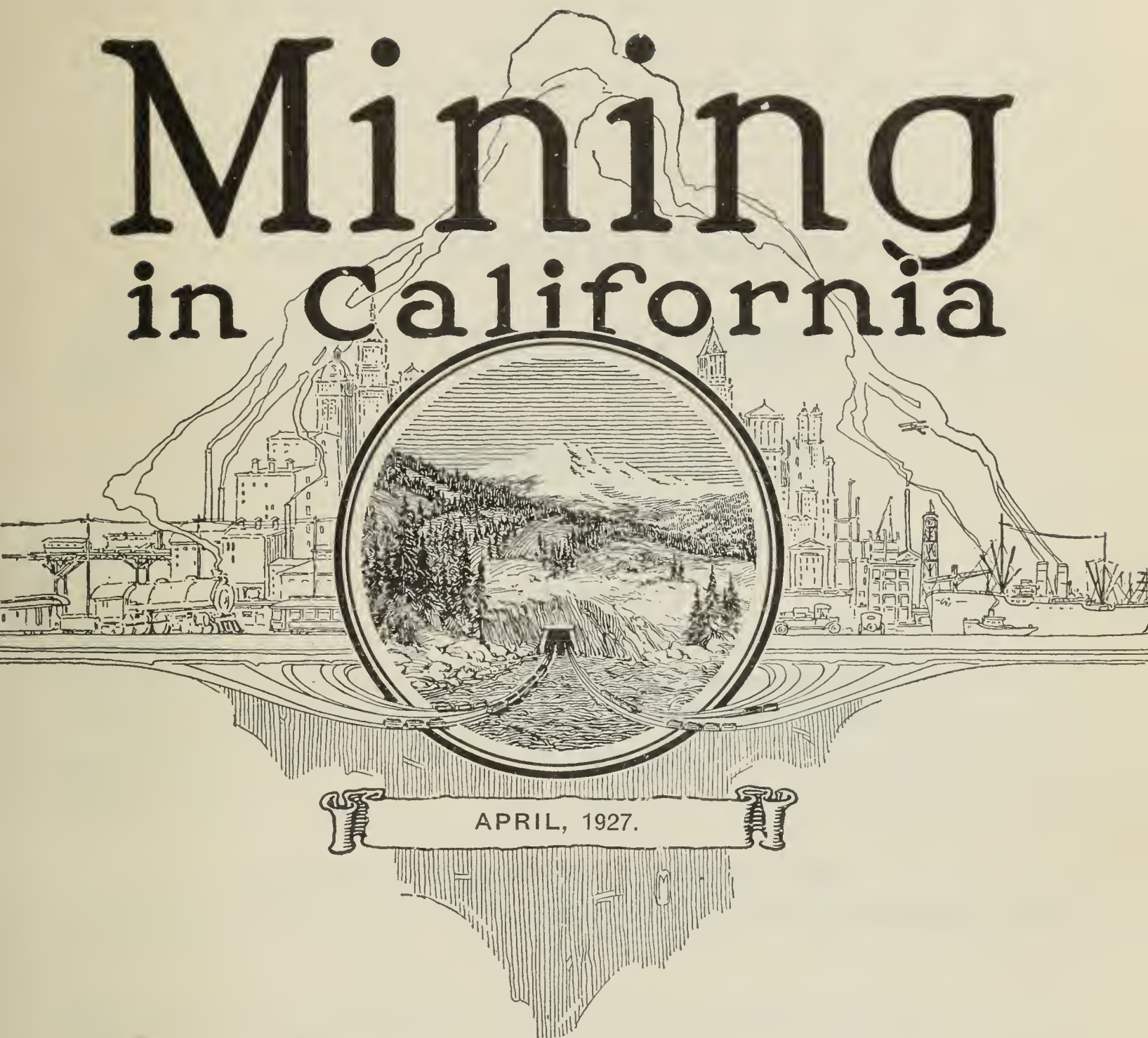
Saturday, 9 a.m. to 12 m.

LLOYD L. ROOT,
State Mineralogist.

Third floor, Ferry Building, San Francisco, Cal.

Branch Offices: New Orpheum Building, Los Angeles; Chamber of Commerce Building (mail address, P. O. Box 1208), Sacramento; Bank of Italy Building, Bakersfield; Taft, Coalinga, Santa Maria, and Santa Paula.

Mining in California



APRIL, 1927.

PUBLISHED QUARTERLY
CALIFORNIA STATE
MINING BUREAU

FERRY BUILDING
SAN FRANCISCO

CALIFORNIA STATE MINING BUREAU

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DEPARTMENT OF PETROLEUM AND GAS

R. D. BUSH, State Oil and Gas Supervisor	-	-	-	-	-	-	San Francisco
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NOTE.—A detailed report of the activities of the Department of Petroleum and Gas is issued monthly by the State Mining Bureau, entitled 'Summary of Operations, California Oil Fields.'

CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT

State Mineralogist

Vol. 23

APRIL, 1927

No. 2

CHAPTER OF

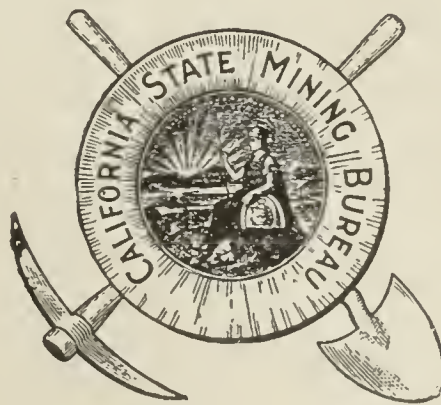
REPORT XXIII OF THE STATE
MINERALOGIST

COVERING

MINING IN CALIFORNIA

AND THE

ACTIVITIES OF THE STATE MINING BUREAU



CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO, 1927

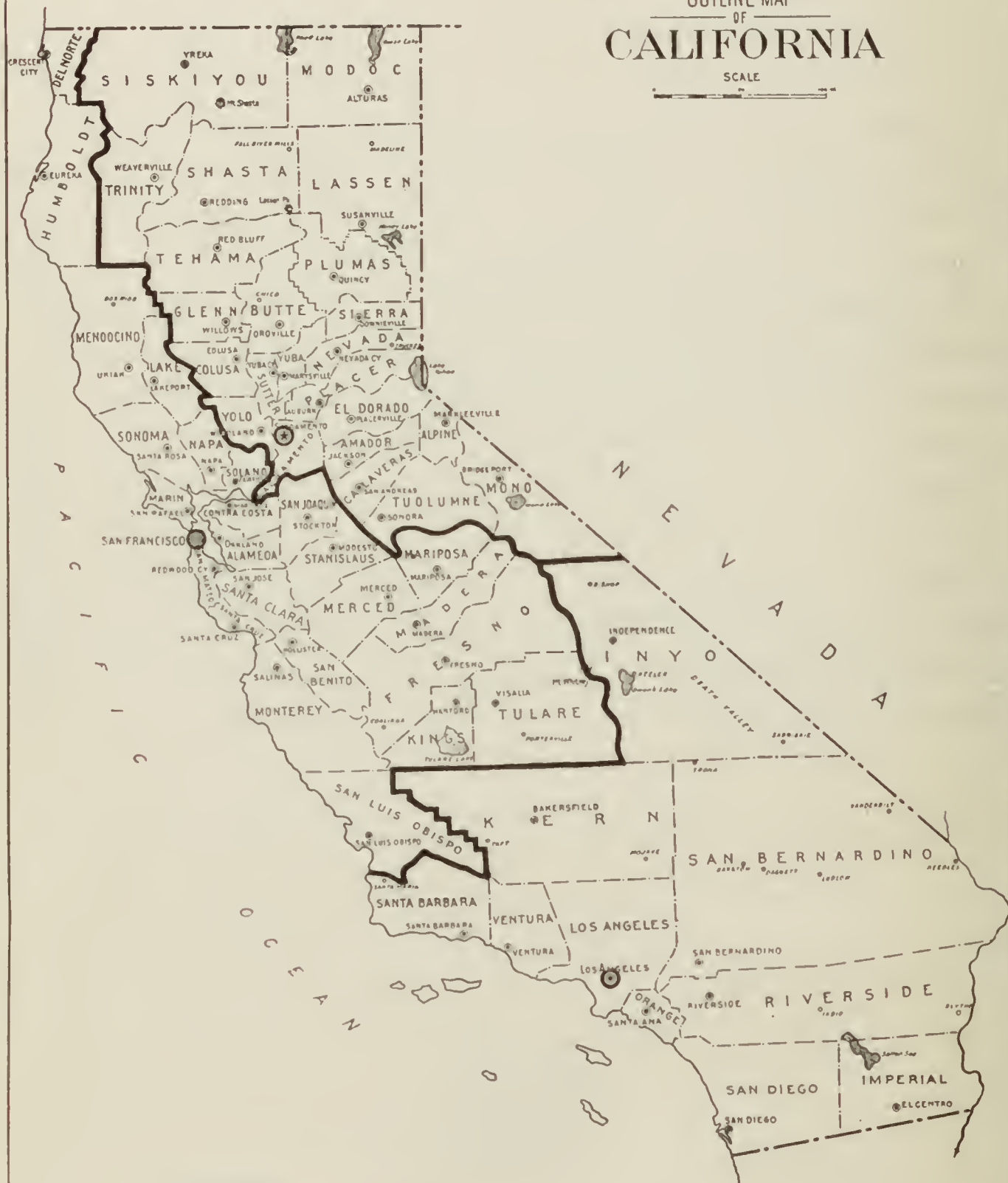
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CALIFORNIA STATE MINING BUREAU
LLOYD L. ROOT
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE
0 10 20 30 40 50 60 70 80 90 100



- LEGEND -

- Mining Division Boundaries
- Mining Division Offices.

MEXICO

PREFACE.

The State Mining Bureau is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

The weak point in work of this character has been that the results of field investigations were so long in preparation that they had lost much of their usefulness by the time they finally appeared in print.

As a progressive step in advancing the interests of the mineral industry, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923.

Owing to a lack of funds for printing, quarterly publication was begun in September, 1923.

For the same reason, beginning with the January, 1924, issue, it has been necessary to charge a subscription price of \$1 per calendar year, payable in advance; single copies, 25 cents apiece. 'Mining in California' will continue to be sent without charge to our exchange list, including schools and public libraries, as are also other publications of the State Mining Bureau.

Pages are numbered consecutively throughout the year and an index to the complete reports is included annually in the closing number.

Such a publication admits of several improvements over the old method of procedure. Each issue contains a report of the current development and mining activities of the state, prepared by the district mining engineers. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance also are reported.

While current activities of all descriptions will be covered in these chapters, the Bureau will not discontinue its practice of issuing from time to time technical reports on special subjects. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters will be subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Mining Bureau is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

DISTRICT REPORTS OF MINING ENGINEERS.

In 1919-1920 the Mining Department was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the Bureau into closer personal contact with operators, and it has many advantages over former methods of conducting field work. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The boundaries of each district were adjusted and the counties now included in each of the three divisions, and the locations of the branch offices, are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the district engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the state's oil fields is included under this heading.

New County Reports.

The series of separate reports on the mines and mineral resources of the different counties, that together comprise the State Mineralogist's Reports XIV to XVII, inclusive, in the case of many of the counties have become exhausted. Those still in stock are in need of revision. It has been thought advisable, therefore, beginning with the January, 1925, issue of 'Mining in California,' to make the district engineers' reports in the form of a complete general report on the mines and mineral resources in one or more of the counties in each district.

This program will be followed as near as possible in succeeding numbers of the quarterly until each county in the state has been covered.

SACRAMENTO FIELD DIVISION.

C. A. LOGAN, Mining Engineer.

AMADOR COUNTY.

Geography.

East of the Sacramento Valley, and extending from the lower foothills to the summit of the Sierra Nevada, Amador is the central one of the Mother Lode group of counties; which are similar as regards climate, geography and natural resources. Amador is smaller in area than its neighbors, and contains only 601 square miles. The population of about 8000 is concentrated in a group of small towns extending along the course of the Mother Lode, including Jackson, the county seat, four miles north of the Calaveras County line; Sutter Creek, Amador City, Drytown and finally Plymouth, near the northerly end of the county.

All of these were early day mining towns, whose entire history has been connected intimately with the successful operation of one or another group of the many gold quartz mines. Ione, west of the Mother Lode, is the seat of an active clay mining region and had formerly active coal mines. Oleta, Volcano, Pine Grove and a few other small settlements east of the lode are placer mining towns of the early days. The higher mountainous part of the county is limited in area, but there is a large acreage of foothill land in the western section, which is divided into ranches devoted to grazing. Mining is the principal industry.

A lateral of the state highway system extends from Stockton to Ione, thence to Jackson, Pine Grove and over the summit to Hope Valley in Alpine County, where it connects with similar roads leading to Lake Tahoe and into Nevada. Another highway from Sacramento connects near Plymouth with the Mother Lode road, a north and south road which extends along the Mother Lode region from Auburn to Placerville, Plymouth, and thence south to Sonora. The county is thus seen to be well provided with roads. A branch of the Southern Pacific railroad extends from Galt to Ione, where it connects with the Amador Central, running as far as Martel, serving the mines in the vicinity of Jackson and Sutter Creek.

Timber, Water and Power.

There is timber suitable for mining in the mountains east of the Mother Lode. Some of the mines ship in heavy Oregon pine timber in addition to utilizing the local supply. Water and power for mining and milling are supplied all along the Mother Lode section of the county by Pacific Gas and Electric Company.

Geology and Mineral Resources.

White clay forms a conspicuous part of the Ione (Tertiary) beds, which extend across the entire west side of the county from north to south. This and other colored clays nearby form the basis of an important industry, supplying potteries in various parts of the state.

Also associated with the Ione beds, and usually within 100 feet or less of the surface, near Carbondale, Ione, Buena Vista and Lancha Plana, occur numerous deposits of brown lignite. This was mined at several places until a few years ago, the branch railroad having been built to Ione primarily to serve the coal mines.

Farther east, alternating beds of Mariposa (Jurassic) black slate, amphibolite schist, serpentine and Calaveras (Carboniferous) rocks extend northwest, parallel to the axis of the mountain range of which they form the flank. In the amphibolite schist numerous copper mines and prospects occur, but are all idle now. Chromite occurs in the serpentine, and many small lenses of limestone in the Carboniferous rocks. These formations begin about a mile east of Ione and extend for seven miles eastward, where the Mother Lode mines occur, in another belt of black Mariposa slate. This slate enters the county at Middle Bar bridge on Mokelumne River, running thence northwest through and beyond the county. With an average width of about one-half mile, and in many of the mine workings narrowing to only a few hundred feet, this slate belt and the immediately adjoining and at times intercalated areas of altered igneous rocks contain all the important gold quartz mines of the county.

To the east of the Mother Lode the rocks are nearly all of Carboniferous age for a distance of ten miles, until an elevation of about 3000 feet is reached, where the granodiorite forming the core of the mountains appears. At Oleta in the northern part of the county and at Volcano much placer gold has been produced. A series of detached gravel bodies covered by rhyolite and andesite extends across the county between these two old camps. The gravel in this region represents remnants of Tertiary river deposits. In the western part of the county, near Ione, are accumulations of delta and shore gravel, deposited when the inland sea or gulf had its shores in that vicinity, during the time of the Ione deposition, which was at the same time as the formation of prevolcanic channels in the rivers of the Sierra Nevada. In places where it has been reconcentrated by later streams some of it has been rich enough to mine profitably. There are also beds of white and red sandstone in the Ione formation, which have been worked in the past. Marble occurs two miles east of Plymouth and eight miles east of Sutter Creek, enclosed in the Calaveras formation. Besides the numerous small bodies of limestone, there are two especially large areas, one at Volcano and one four miles northwest of that town. Asbestos, talc, ocher and low grade iron ores also occur.

Foreword.

As a part of the work of the Bureau, the people of the state in general and those who come here to invest their money in mining have a right to expect in our reports definite information as to results actually obtained in mining. The only way this can be satisfactorily given is to publish details of the results of actual mining operations, rather than to deal in generalities. The prospective operator wants to know the average grade of ore which he may reasonably expect to find in a given district, the size of orebodies and character of ores, and the average operating costs. The more complete and comprehensive such data are the better, as his proposed venture then contains fewer factors of uncertainty and approaches the ideal so nearly realized in the gold dredging industry, which has in recent years taken on the aspect of an attractive manufacturing project. The general public, too, advances for mining much larger sums than is realized. Such people as a rule can participate in mining only by buying stock in those companies which are financed by large numbers of small subscriptions. If the State Mining Bureau can make available to them exact information as to what has been and is being done in the industry, with a proper conception of the accompanying conditions, it has more than justified its existence.

The reports herein on many of the principal mines of Amador County have been prepared with these aims in view. The gold mining industry is entirely noncompetitive, and no conceivable injury to the interests of operators can result from publishing such information as appears.

Acknowledgment.

The writer wishes to acknowledge with thanks the assistance given by most of the important mining companies and particularly by Argonaut Mining Company, N. S. Kelsey and Harry Sheaf, its general managers at different times; Bunker Hill Mining Company, Central

Eureka Mining Company and its superintendent, Albion S. Howe; Old Eureka Mining Company, Moore Mining Company, Plymouth Consolidated Mining Company and W. J. Loring.

ASBESTOS.

On the *Mace Ranch* in the N.E. $\frac{1}{4}$ Sec. 20, T. 6 N., R. 10 E., $2\frac{1}{2}$ miles northeast of Ione, asbestos occurs in irregular veins along the contact of serpentine and amphibolite. According to a field report by C. A. Waring,¹ this asbestos is of the amphibole variety and some of it is 12 inches long, occurring as slip fiber with some cross fiber. He described it as low-grade, siliceous and in small amount, as shown in the limited open cut prospecting work. Idle.

The occurrence of some chrysotile asbestos in the serpentine on this property is mentioned also in Bulletin 38.

The Mace Company, Ione, owner.

CHROMITE.

Like all the other counties east of the Sacramento Valley, Amador County was a producer of chromite during the late war, and a little ore was produced also in 1909. The yearly output was small, amounting to 585 tons in 1916, 65 tons in 1917 and 88 tons in 1918. There is no record of any chromite being sold in recent years.

The following properties were listed in Bulletin 76:

Name	Location			Shipping Point
	Sec.	Twp.	Range	
Carr & Mefford	34	6	10	A. C. R. R. 2 mi. haul
Courtwright	2	5	10	Ranlett, $2\frac{1}{2}$ miles
Detert Ranch	6	7	10	Carbondale, 8 miles
Dooley	Near	Wait's	10	Carbondale, 6 miles
Wait				Carbondale, 6 miles

CLAY.

Clay of different colors and grades is produced in large quantity from numerous pits in the vicinity of Ione and Carbondale. One plant for the manufacture of fire brick has been in operation for many years. A clay-washing plant has lately been built. The clay is shipped to nearly every pottery and brick making plant in the state, entering into a great variety of products.

The clay occurs as a part of the Ione (Tertiary) beds and is distributed over a length of 12 miles and a width of $4\frac{1}{2}$ miles in this county, but extends both northwest into Sacramento County and southeast into Calaveras. For the most part it is covered only by a soil and sand overburden, varying from a few inches up to a maximum of 20 feet. In a few places, as southeast of Buena Vista, it is overlain by tuff, breccia, and sandstone. It lies nearly flat, having a westerly dip of only a few degrees. The beds have been drilled in several places, and while the series is not uniform in either thickness or character, there is an ample supply. Lignite coal is interbedded with the clay, lying usually at a depth of 80 to 125 feet, where it has been worked or drilled, but in places at 40 feet or less. This lignite would probably mark the limit of clay mining in any event.

¹ Formerly Field Assistant, State Mining Bureau.

MINERAL PRODUCTION OF AMADOR COUNTY, 1880-1926.

Year	Gold, value	Silver, value	Coal		Copper		Pottery clay		Lime		Marble		Brick		Miscellaneous and unapportioned			
			Tons	Value	Pounds	Value	Tons	Value	Barrels	Value	Cu. ft.	Value	M.	Value	Amount	Value	Substance	
1880	\$1,495,053	\$1,953																
1881	1,450,000	1,500																
1882	1,500,000																	
1883	1,590,000																	
1884	2,000,000	2,000																
1885	2,145,591	3,700																
1886	1,874,062	6,136																
1887	1,979,956	2,069																
1888	1,750,000	3,500	24,404	\$36,606														
1889	1,560,975	0,398	30,000	45,000														
1890	1,459,952	9,357																
1891	1,395,902	13,895	21,323	31,984														
1892	1,210,383	8,008																
1893	1,505,973	5,230																
1894	1,331,916	280	15,280	23,020			2,500	\$3,000			25,941	\$35,826						
1895	1,391,929	1,089	21,323	31,985	16,500	\$1,050	9,960	10,285			4,864	6,566						
1896	1,523,351	3,767	19,775	29,662	30,000	3,000	8,413	27,825			4,389	5,415						
1897	1,324,472	3,477	20,000	25,000			3,492	9,540			3,864	6,280						
1898	1,806,363	1,742	18,500	29,550	3,000	300	7,197	8,297			2,850	3,594						
1899	1,544,868	6,902	18,500	23,125			10,700	10,900			4,582	7,925						
1900	1,373,788	14,915	27,477	41,215	220,000	34,100	11,500	9,100			4,103	5,891				\$318,422	Unapportioned, 1900-1909.	
1901	1,823,827	7,444	25,000	30,000	52,000	8,190	10,050	7,100			2,945	4,630	600	\$7,000				
1902	1,629,151	2,680	5,450	10,912	130,000	14,620	12,723	13,728			6,300	8,010						
1903	1,609,744	4,336			10,000	900	22,000	19,460			3,074	5,379						
1904	2,060,574	4,055			14,000	1,400	20,608	10,770	1,700	\$1,700	4,785	6,558				750	Glass sand.	
1905	2,445,815	17,930			10,000	1,560	21,775	20,000	1,000	1,500	2,703	3,950						
1906	2,260,373	14,570				8,648	1,009	26,789	28,119	1,000	1,200							
1907	2,116,182	13,515				5,300	1,020	12,465	13,992						1,000 tons	1,200	Limestone.	
															10 tons	1,000	Asbestos.	
1908	1,876,175	13,239			53,940	3,440	23,322	25,369	800	960			2,109	61,369	1,072 lbs.	40	Lead.	
1909	2,298,785	16,701			288,472	36,641	33,563	32,724	1,200	1,440			1,429	28,572	1,000 tons	1,375	Limestone.	
															2 tons	200	Asbestos.	
															41 tons	332	Chromite.	
1910	2,646,246	20,916			151,484	14,380	39,446	49,339	1,400	1,680			2,000	30,000	1,000 tons	1,500	Limestone.	
															10,100 tons	10,100	Quartz sand.	
															11,200 cu. ft.	5,600	Sandstone.	
															600 tons	6,000	Soapstone.	
1911	2,832,395	28,899			227,848	28,481	43,352	37,359	1,200	1,500			2,000	20,000	90,000 cu. ft.	45,000	Sandstone.	
1912	2,796,194	32,037			175,608	28,975	35,100	36,856	800	1,040			2,500	25,000	6,000 cu. ft.	3,000	Sandstone.	
															700 tons	2,100	Soapstone.	
															2,500 cu. ft.	2,500	Sandstone.	
															350 tons	2,420	Soapstone.	
1913	2,901,898	18,097			19,023	2,949	39,678	38,653	1,000	1,200			2,000	30,000	1,960 tons	3,556	Quartz.	
															877 tons	670	Glass sand.	
																670	Miscellaneous stone.	
																11,237	Other minerals.	
															16,888 tons	9,855	Glass sand.	
1914	3,082,002	17,032	5,700	10,062	5,251	694	32,223	33,114	1,540	2,008			2,500	50,000	44 lbs.	2	Lead.	
															6,250 tons	2,400	Quartz.	
															3,960 cu. ft.	1,500	Sandstone.	
															610 tons	2,440	Soapstone.	
1915	3,894,125	20,409			4,185	732	40,156	38,879	1,000	1,200			4,000	80,000	523 lbs.	25	Lead.	
															13,339 tons	16,142	Silica.	
																1,300	Miscellaneous stone.	
																10,950	Other minerals.	
																300 tons	3,700	Chromite.
1916	3,060,550	18,705			12,349	3,038	29,246	31,106							4,341 tons	12,802	Silica.	
															495 tons	2,475	Soapstone.	
																1,300	Miscellaneous stone.	
																77,752	Brick, coal, lime, manganese, sandstone.	
1917	3,664,164	21,358			19,352	5,283	28,970	28,625							65 tons	1,420	Chromite.	
															4,771 tons	20,766	Silica.	
																1,200	Miscellaneous stone.	
																13,033	Coal, lead, manganese, platinum, soapstone, zinc.	
															88 tons	4,400	Chromite.	
1918	3,249,385	29,590					13,562	34,346							13,747 tons	61,724	Silica.	
																6,500	Miscellaneous stone.	
																66,695	Brick, coal, copper, manganese, mineral paint.	
																	platinum, soapstone.	
																	Clay and clay products.	
1919	2,920,492	33,254													8,440 tons	67,366	Silica.	
																9,953	Coal, manganese, platinum, sandstone, soapstone.	
1920	1,788,793	19,780					25,719	61,808							6,116 tons	36,432	Silica.	
																680	Miscellaneous stone.	
																102,707	Brick, coal, mineral paint, platinum, soapstone.	
1921	2,167,443	35,400					22,124	46,664							1,802 tons	20,646	Silica.	
																1,125	Miscellaneous stone.	
																97,126	Brick and platinum.	
1922	2,241,100	32,287					39,572	68,126							865 tons	5,030	Silica.	
																7,300	Stone, miscellaneous.	
1923	1,734,133	15,153					45,887	58,196								125,220	Other minerals. ²	
																28,515	Stone, miscellaneous.	
1924	2,700,508	18,251					64,317	87,444								119,877	Other minerals. ³	
																3,050	Stone, miscellaneous.	
1925	2,338,101	16,123					03,889	95,946								123,612	Other minerals. ⁴	
																31,100	Stone, miscellaneous.	
1926	2,167,275	13,422														11,003	Other minerals. ⁵	
Totals	\$98,126,024	\$581,076	252,732	\$368,121	1,458,960	\$193,028	900,623	\$322,352	12,640	\$15,428	70,400	\$100,030		\$427,286		1,612,598		

¹ See under 'Unapportioned.'

² Includes brick and platinum.

³ Includes brick and soapstone.

⁴ Includes brick, coal, copper and lead.

⁵ Includes coal, copper, lead and marble.

The white clay apparently came from the rhyolite ash flows, which have been found directly over the older series of gold-bearing gravel channels in the Sierra Nevada. Probably a long enough period of erosion ensued after these initial ash outbursts to permit the carrying of the finer sized and lighter particles down the streams into the shore waters of the inland sea which then filled the Sacramento and San Joaquin valleys. Before the white ash was covered and preserved by later flows of darker colored breccia and ash, a large part of it was thus swept away.

That the clay is of rhyolitic origin, possibly mixed with the quartz sand from those mysterious earlier rivers whose remaining sections show such a remarkable amount of quartz cobbles, with scarcely any other rock, is substantiated by the analyses. The sandy clay carries about 70% silica, 20% alumina, $1\frac{1}{4}\%$ iron oxides, 0.3% CaO and 0.2% MgO. Other samples where the percentage of silica is less, contain 32% to 34% dry weight of alumina. The amount of calcium is typically low and it is erratically distributed, sometimes as gypsum seams. As the percentage of iron increases the clay becomes mottled red and yellow, but the usual color is white, cream or light blue.

During the war, when imports of Belgian sand were cut off, a plant was operated near Ione to wash and separate sand and kaolin. This plant was described and pictured in Preliminary Report No. 7. The sand was used to make sodium silicate and the kaolin for heavy hotel ware and fine pottery. Sand was also mined in the district and after washing in a plant at Antioch was used for glass making. These markets were lost when importation of foreign sand was resumed.

A new use for Amador County clay is in making cement. One of the large companies has recently bought clay land and is using the clay.

Bacon & Bacon. Mark J. Bacon, manager, Ione. This firm has expanded its operations and is the largest operator in the district. They do a general clay mining business, working some properties for the owners under contract and also shipping to numerous consumers from pits which they themselves own or lease.

The work begins early in April and extends through the dry season.

Twenty-five men, two steam shovels and six trucks are employed. They operate two pits under contract for N. Clark & Sons, one at Clarksona and one near Carbondale, and a pit for Pacific Portland Cement Company near Carbondale. A red mottled clay used for tile is mined near Lane's spur, east of Ione. The Chocolate Pit and Bacon Blue Pit near Carbondale, and the Baker Hill, Yaru and Gage Pits near Lignite, are also worked, furnishing clay for a variety of uses. The average overburden is from two to ten feet, and the deepest 60 feet. Some of the pits have to be pumped at the first of the season. The steam shovels and trucks handle a large tonnage in a short time for some of the consumers. The Sand Pit, near Shepard spur, contains sand clay running 60% or more silica and is used for firebrick and art tile principally.

Barber Pit is on the Arroyo Seco grant, one mile east of Ione, and is served by a spur track of the Amador Central Railway. Barber mines the clay under contract for Mark J. Bacon, Ione.

The sandy white clay has been opened to a depth of about 20 feet and is overlain by six to ten feet of mottled red sandy clay carrying

modules of red iron oxide. (See photo.) The deposit is worked by a series of wide drifts, 12 to 14 feet high, leaving pillars, and a large amount of clay has been removed. No. 2 stumping powder is used for blasting. The clay is hauled in cars by a horse and dumped directly into the railroad cars, only a few feet outside the workings.

N. Clark & Sons Company own clay property near Clarksona and Carbondale. All clay at present is mined for them under contract by Bacon & Bacon. At Clarksona they have large clay storage sheds with a capacity of over 20,000 tons. Clay is hauled to the sheds during the dry season and stored. The sheds adjoin the railroad track, and clay can be loaded directly into box cars as needed at the plant in Alameda.

Clark Sand Pit. Owners, N. Clark & Sons Company, Alameda. This pit is 1.8 miles north of Carbondale railroad station.

Possibly five acres have been worked here, to depths varying from 12 to 25 feet. The deposit is white sand with comparatively little clay.



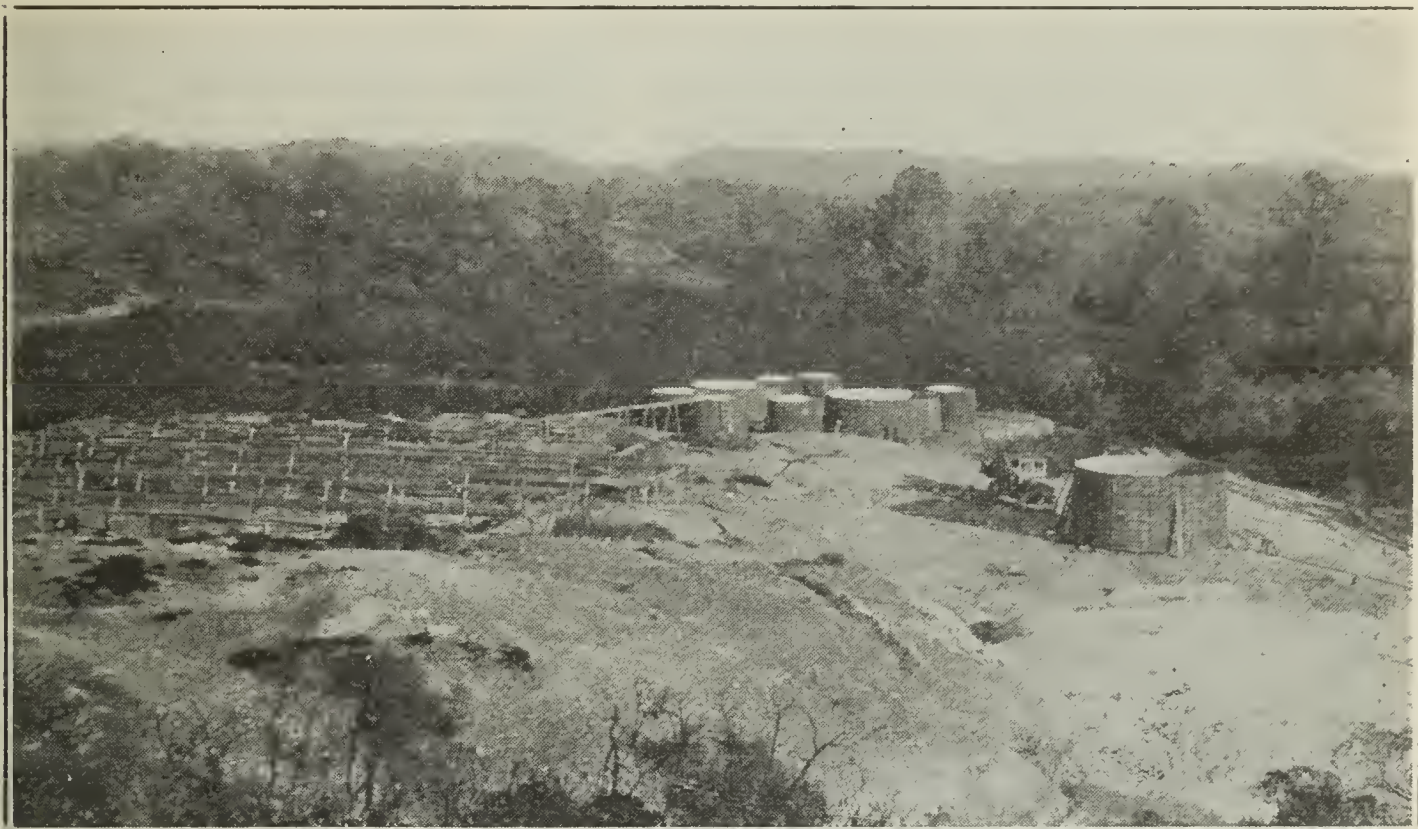
Barber Sand Pit, one mile east of Ione.

It is overlain by one to six feet of soil which contains a great deal of the impure, sandy, concretionary iron oxide characteristic of the soil covering so many of the deposits in the region. Most of the sand has been taken from open pits by hand or steam shovel, but in one place it was mined by wide drifts, high enough to permit a truck to be backed underground. The property was idle when visited April 18, 1927, and water was standing in some of the pits, which would have to be pumped. This property formerly belonged to the Steiger Terra Cotta and Pottery Company, and is in Secs. 20 and 28, T. 7 N., R. 9 E.

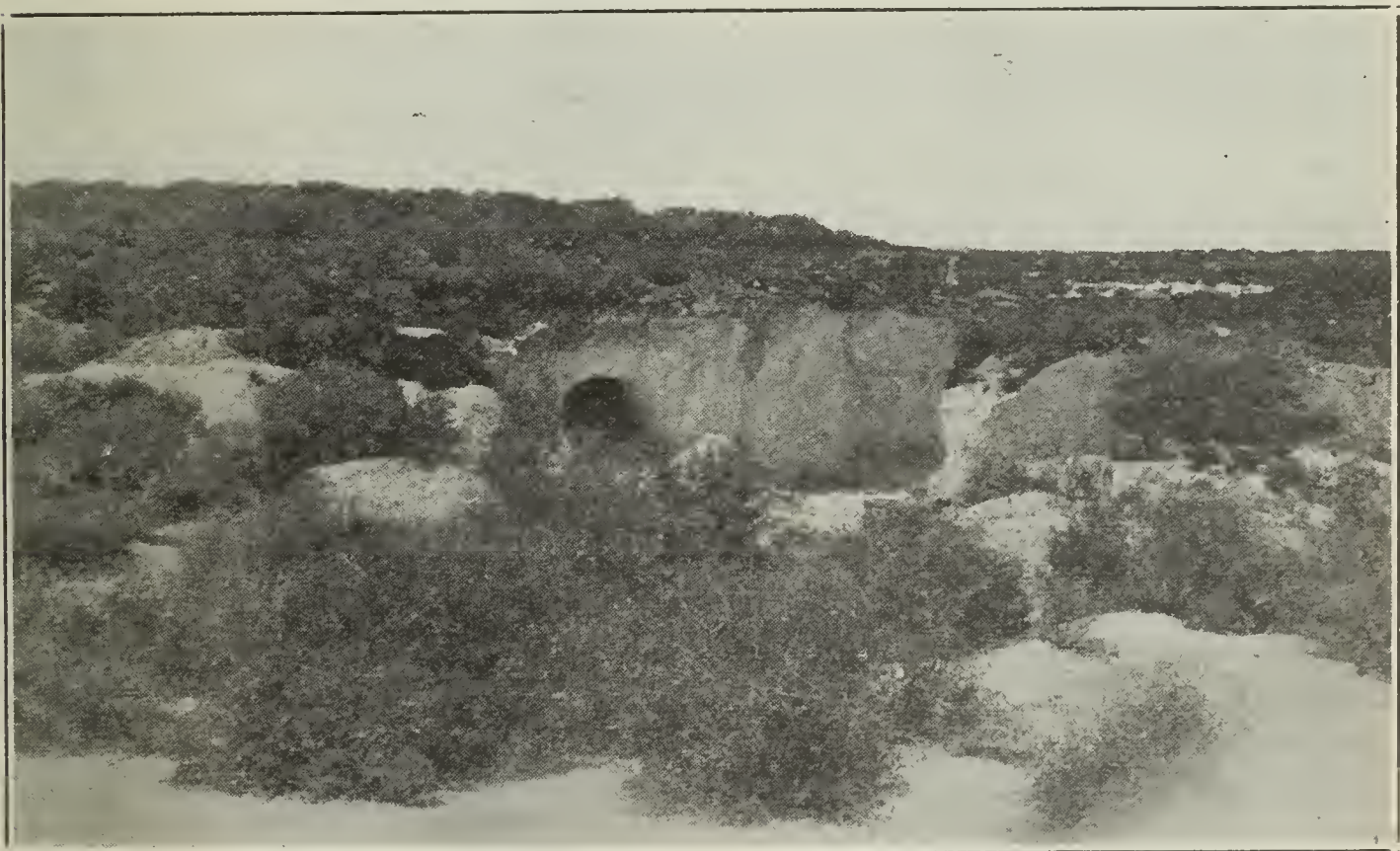
The company's clay pit is near the state highway and just north of Clarksona.

Carlile Clay and Sand Deposit. Owner, Mrs. Sarah E. Carlile, Ione. Lessee, E. E. Tremain, Buena Vista, via R. F. D., Ione. The property contains 60 acres in $W\frac{1}{2}$ of $NW\frac{1}{4}$ Sec. 8, T. 5 N., R. 10 E., four miles from Ione and 2.8 miles by road to the nearest railroad spur. It is a new property, being opened for the first time.

Tremain is erecting a plant (Feb., 1927) to wash the sand and clay. A bed of white sandy clay, overlain by two to seven feet of brown clay, has been stripped over an area about 80 feet square. According to present plans, the clay will be dug by drag-line scraper. The washing and settling plant comprises several hundred feet of sluices with sand



Carlile Property, near Buena Vista, showing plant being erected by E. E. Tremain for washing clay.



Clark Sand Deposit, about two miles north of Carbondale.

traps and eight large clay settling tanks. The sand is expected to settle out on the way through the sluices and traps, leaving the clay in suspension, free from grit, to pass to the settling tanks, from which it will be drawn, filtered and dried. The estimated capacity is 10 tons a day. The sand is not at present being considered for marketing!

Harvey Pit. Pacific Portland Cement Company Consolidated, Pacific Building, San Francisco, owner. This is part of over 1000 acres of land recently purchased from Fred Harvey. The pit is just east of the old Harvey coal mine, and one mile north of Carbondale station. The land is in Secs. 32, 33 et al., T. 7 N., R. 9 E.

Blue clay occurs with an overburden of from two to three feet of soil in which are found occasional concretionary boulders of red iron oxide. The overburden is removed by plowing and scraping, using a tractor for power. The clay has been dug to a depth of about 12 feet by a small steam shovel. This loads the clay into trucks which deliver it to the railroad.

This clay contains about 32% alumina (dry weight) and is being used in the manufacture of cement. It is also used in making sewer pipe and terra cotta.

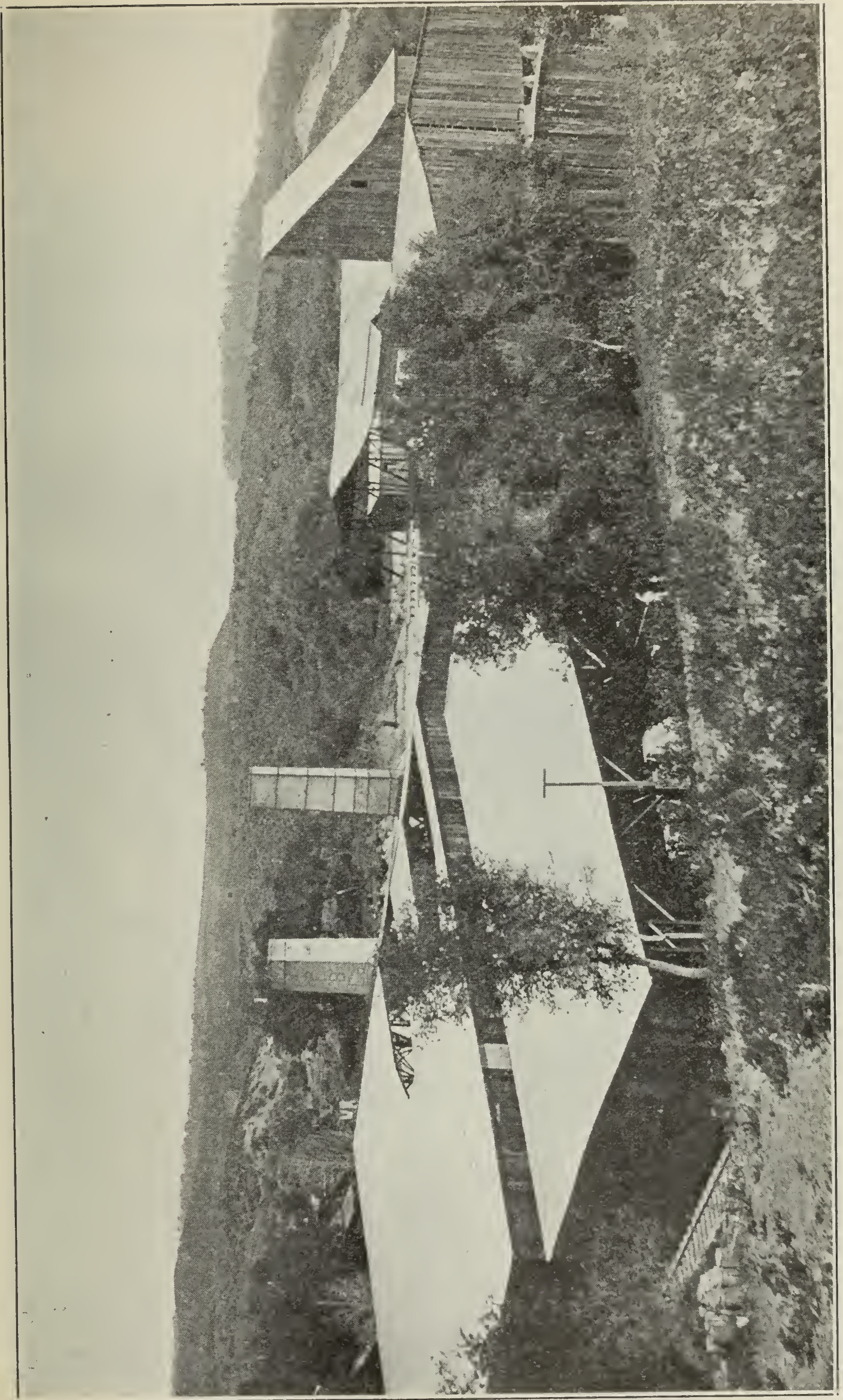


Harvey Clay Pit of Pacific Portland Cement Company, near Carbondale.

Ione Fire Brick Company. Main office, Rialto Building, San Francisco. Wm. Brown, Ione, superintendent. The plant is $1\frac{1}{2}$ miles east of Ione, on the Amador Central Railway.

There are five round kilns, each 30 feet in diameter, down draft, with a capacity of 65,000 to 70,000 bricks each. Crude oil is used for fuel. It is atomized by compressed air, furnished by an electrically driven centrifugal compressor, furnishing just sufficient pressure for atomizing.

Clay is obtained in part from Lincoln, Placer County, and in part from a pit one mile from the plant near Shepards and from a 'grog' pit near Bacon's mottled clay pit, on the Jackson highway. The Lincoln clay is said to carry a little more silica and to show less shrinkage than local clay. The 'grog' pit also has a high silica content, as this deposit is quartz sand and gravel. The company works two men in each of the local pits. Clay is brought to the plant in railroad cars over an elevated spur track and dumped on a concrete floor from which a new belt conveyor being built will deliver it to the dry pan for



Plant of Ione Fire Brick Company, one mile east of Ione.



New Clay Pit, May E. Newman Estate, near Ione.

grinding. Clay is then raised to bins by bucket elevator, and fed thence to the pug mill, brick machine, cutting table and brick presses. The brick-making machinery has a capacity of 23,000 bricks a day (8 hours).

Bricks are burned eight days, of which time five days are required for gradual heating to the maximum temperature, cone 12, or 2496° F., which is held for three days. Two Elwell-Parker electric trucks, run by storage batteries and having a lifting capacity of two tons each, are used for handling brick. The product is shipped throughout the west, being used largely for locomotive fire-boxes, which put a severe test on firebrick, because of the extremes met with on mountain traffic. The plant works only in the dry season and employs 18 men.

Lane Mottled Clay Pit is near Lane's spur, on the Amador Central Railroad, a mile and a half east of Ione. Bacon & Bacon lease and operate it.

A loam overburden of one to three feet is stripped by hand. A row of flat holes six feet deep and five to six feet apart is bored along the bottom of the bank, which is 10 to 25 feet high, and the bank caves when these holes are blasted. The clay is then loaded by hand into trucks and hauled about one-fourth mile to the railroad. A large tonnage of this clay was shipped for use in tiling in 1926. There is said to be 20 feet of the same clay below the bottom of the pit.

Livermore Fire Brick Company has worked for some years a pit on the J. M. Fancher ranch, five miles south of the Amador Central Railway, and southeast of Ione. The clay is hauled in small trucks to a platform reached by an inclined driveway. The trucks dump from this directly into the cars on the railroad spur.

May E. Newman Estate. Main office, 980 Bush Street, San Francisco. C. W. Forbes, superintendent at the pit, Ione. This is the property formerly operated by J. Newman as the Newman Clay Company. It is one mile east of Ione and the main line of the Amador Central Railway passes within a few feet of the pits.

The old pits, operated for years south of the track, have been worked up to the property line. A new pit has recently been started on the north side of the track. In vertical section, so far as opened, it shows from top to bottom 25 feet of overburden, 10 feet of red mottled clay and 15 feet of white sand. The red mottled clay now being shipped for testing (April 18) is said to carry a little more sand than the Bacon mottled clay. Nine men were employed on that date. Clay is mined by hand in an open pit and hauled in a small truck to the railroad cars, a few hundred feet away. It is thought this clay will prove suitable for tile. The white sand is stated to run about 71% silica. If regular production starts, drifts will be run to avoid handling the overburden.

Stockton Fire Brick Company, Stockton, has for years obtained fire clay from a pit one mile south of Clarksona on the Southern Pacific Railroad, their shipping point being only a short distance west of Clarksona.

The deposit was opened originally as an open cut on the southeast side of a hill, but more recently has been worked by drifting to avoid

handling the rapidly increasing overburden, as the work advances into the hill. A vertical section shows the following formations:

3 feet soil and andesite boulders, increasing uphill
10 feet white and iron stained sand and sandy clay
10-14 feet white fire clay
red clay

The property was idle when visited in April.



Yaru Clay Pit, near Carbondale.



Clay Storage and Loading Sheds of N. Clark & Sons Company, at Clarkson.

Yaru Clay Pit is at Lignite spur, a short distance east of Carbondale. It is within the Arroyo Seco Rancho and is operated by Bacon & Bacon under lease. Four men and a small truck were employed in April, 1927, when visited.

An overburden of four to six feet of soil and sand is removed by hand labor. The upper clay bed is second quality clay, stained yellow,

and is about nine feet thick. A black layer a few inches thick separates this from the better quality, which is light gray. This lower bed is 16 to 17 feet thick and is used for light-colored tile and fancy products.

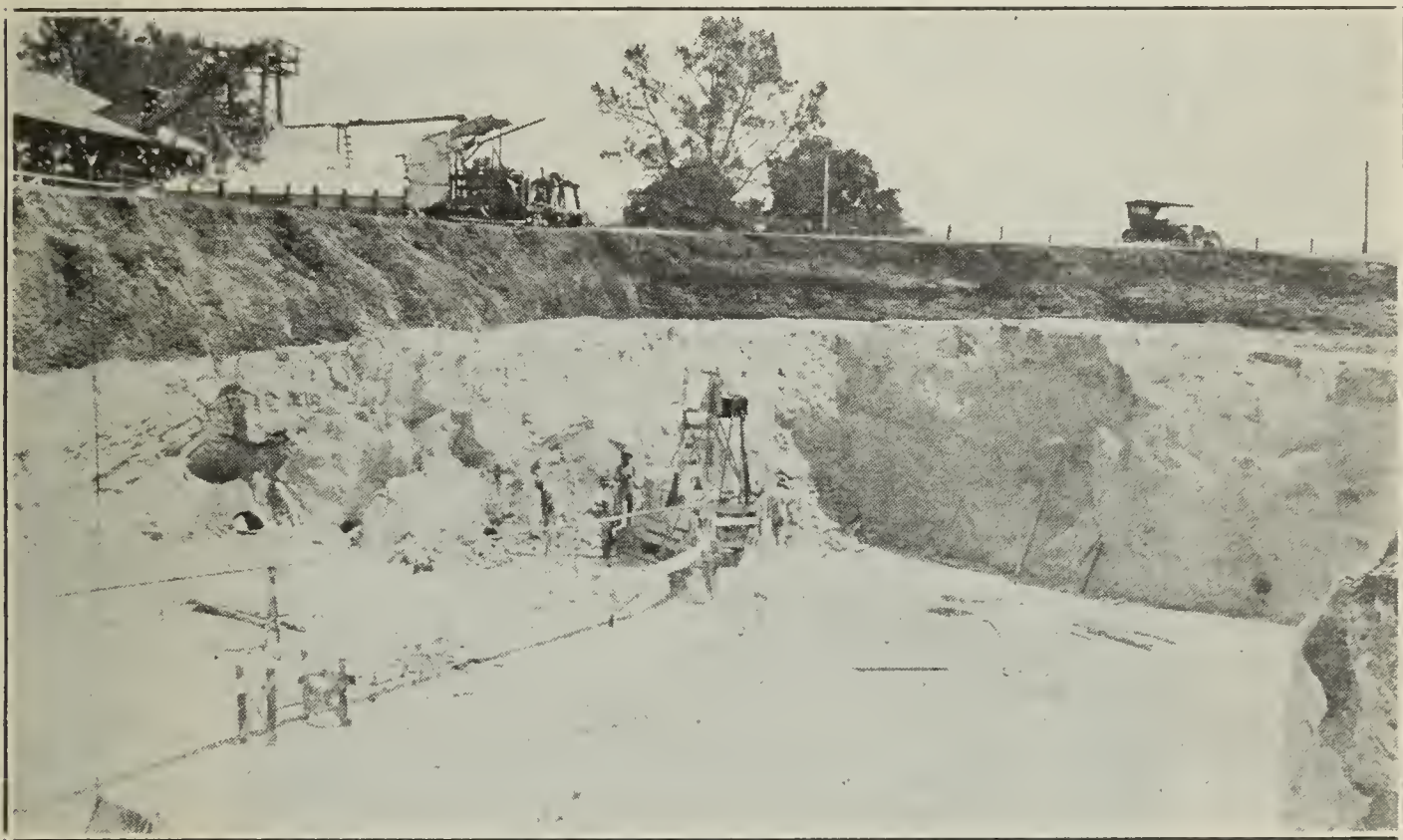
This deposit has been drilled to a depth of 90 feet, where lignite was struck. A sand bed containing considerable iron was struck between the clay and lignite.

The clay is dug and loaded by hand and hauled about 100 yards to a drying shed beside the railroad track. From there it is loaded on the cars with wheelbarrow, usually after aging several months.

CHANGES SINCE FORMER REPORTS.

The following changes have occurred as regards companies in the Amador clay industry, listed in our Preliminary Report 7, of January, 1920, and the Nineteenth Report of the State Mineralogist, 1923:

Amador Kaolin Company. Out of existence.



W. D. Amick White Sand Deposit, near Ione, Amador County.
(The plant shown has not been in commission for several years.)

W. D. Amick Property (formerly operated by Philadelphia Quartz Co.). Idle. This deposit is one-half mile from Ione and is essentially a white sand deposit, with 70% to 80% sand and 20% to 30% kaolin.

The last operators worked it in an open pit (see photo). The overburden was stripped and the sand shot from the bottom and caved. It was then shoveled into a beater where it was ground to a freely flowing pulp and pumped to drag classifiers, which pulled out the sand. The clay in suspension in water passed through 1000 feet of sluices with a grade of one inch in 80 feet, and was caught in six redwood tanks, and finally passed to six larger tanks for settling. From the tanks the product was pumped to filter presses and the filter-cake was sun-dried, ground and sacked. The sand was freed of heavy black minerals by running it over James ore concentrators, which gave a final product carrying 98% silica. This was used in making sodium silicate. The washed kaolin contained just sufficient iron to burn a light straw color,

and was used for fancy pottery and heavy hotel ware. These operations ceased when imports of the cheaper Belgian sand were resumed after the war.

McKissick Cattle Company. Former owner of Rancho Arroyo Seco, a grant of 33,000 acres on which occur many of the clay and sand deposits described, *ante*. These deposits are being operated by Bacon & Bacon, under lease held by G. A. Starkweather.

Newman Clay Company. Now *May E. Newman Estate*.



Clay Storage and Loading Sheds, at Carbondale,
used in Bacon operations in that vicinity.

Philadelphia Quartz Company. Has withdrawn from the county as a producer.

COAL.

Lignite was first exploited in Amador County as early as 1871, according to Goodyear. From then until 15 years ago production continued irregularly. Since that time oil for fuel, and electric power, have replaced coal to such an extent that there has been practically no lignite production. The demand for crude oil and its products is now so great, without assurance of development of new fields adequate to keep pace with the increase, that attention is turning to the possi-

bilities of domestic lignite. While there are large deposits of black lignite in other counties, the brown lignite beds of Amador County are not only extensive, but also conveniently located, with a broad gauge railroad crossing the deposits. As it is centrally located, as regards population, this district is in a position to benefit first from the utilization of such coal.

The possibilities of the Amador lignite include the making of briquettes, the preparation of powdered fuel or amalgam and the distillation of oil and its products. The beds lie generally within 125 feet of the surface and mining is cheap, so that if the lignite would stand transportation without crumbling it could compete successfully with any coal now brought into California for fuel purposes, as far as comparative costs and fuel value are concerned. In a report¹ on 'Gas Making and Fuel Problems of the Gas Industry of California,' Wm. W. Odell, Fuel Engineer, states his conclusion that "the coals of California are not well adapted for use in gas-making processes now in common use," and cites the sulphur and ash content as impediments. His report was the result of cooperation between the U. S. Bureau of Mines and the California Gas Research Council, an incorporated association supported by California gas companies.

The line of most promise for future development of these deposits, so far as experiments show, lies in the direction of making briquettes from the previously carbonized and treated lignite. The domestic market, where outside coal is now retailing for \$17 a ton in winter, includes Sacramento and Stockton, both within 50 miles of the mines and having a combined total population of over 150,000, and adjacent parts of the Sacramento and San Joaquin valleys. The coal now in the market is not of high quality considering the price, but is cheaper than wood, so an opportunity for competition is indicated. At one time, many years ago, a briquette plant was operated for a short time near Ione by the Lignite Fuel Company. There is no record of why this suspended, but a few of the briquettes have been preserved as specimens. They have retained their original shape, are quite hard and compact, and do not crumble or soil the hands. They are said to have been made from the crude lignite without binder. The total production of coal from Amador County has been between 250,000 and 300,000 tons, practically all previous to 1902.

The lignite occurs as nearly flat beds in the Ione (Tertiary) strata. It dips west a few degree in places where drilled, and elsewhere occurs in the shape of flat saucers or lenses. It was probably deposited in a chain of marshy lakes stretching across the county from Lancha Plana to the county line northwest of Carbondale. The vicinity of Ione was along the ancient shore in those times, and the various sand and clay beds were erratically deposited, so that sections taken through the formations at different points would not be uniform. The Ione beds are made up of clay, sand and various gradations between the two. While white, sandy clay is characteristic, there is also much loose sand and grey and red mottled clay, stained by iron oxide. The brown lignite as it stands in the mine has a somewhat waxy appearance and is solid and homogeneous, containing considerable water. On drying at the surface it checks and breaks and loses weight. The vestiges of woody texture

¹ U. S. Dept. of Commerce, Bureau of Mines, Report of Investigations, Serial No. 2769, Sept., 1926.

and the bark, apparently of coniferous trees, are often evident. Lumps, probably of ionite, a brownish yellow, earthy hydrocarbon, occur in it occasionally, especially at the Buena Vista Coal Mine. The ionite burns freely when lighted with a match.

Buena Vista Coal Mine. Lessees with option to purchase, J. J. Morris and Darling Brothers, Buena Vista via Ione. The total holdings under lease are 75 acres from the Arroyo Secco Grant and 280 acres adjoining in the E $\frac{1}{2}$ Sec. 19, T. 5 N., R. 10 E., six miles from the nearest railroad spur east of Ione.

This mine was worked in 1913 by J. J. Fitzsimmons and some coal was sold locally. Since then, until 1924, it lay idle. The present lessees sank a new shaft a depth of 122 feet on an incline of about 45°.



Buena Vista Coal Mine, the only recently active lignite mine in Amador County.

This showed the following section when reduced to vertical equivalents, the vertical depth being 70 $\frac{1}{2}$ feet:

- 50 feet—quartz sand
- 9 $\frac{1}{2}$ feet—grey clay
- 1 foot—low grade coal
- 1 foot—clay
- 9 feet—good coal

The following drifts were open when the mine was visited in 1924 and 1926:

- 110 feet south in coal
- 95 feet east in coal to old shaft
- 90 feet west in coal from old shaft
- 35 feet north in coal from old shaft

An old drift 300 feet long in coal east of the old shaft, with coal blocked out 40 feet wide, was believed still open. There was also a drift west 100 feet from another old shaft, which lies north of the north drift and which was expected to be entered within 20 feet. A drill

hole 500 feet east of the new shaft was said to have shown coal 17 feet thick; 1000 feet south of this, a hole is reported as showing 20 feet of coal.

A few hundred tons of the lignite were mined and sold in 1925 and 1926. A hoist is operated by an automobile engine. There is a good storage building.

The following is an analysis of the Buena Vista coal, showing a high moisture content, even for this district:

Fixed carbon -----	39.8 %
Volatile hydrocarbons-----	22.75%
Ash -----	8.35%
Sulphur -----	0.90%
Moisture -----	28.00%

Tested after drying 10 hours at 105° C., this sample had an indicated heating value of 6366 calories.

Harvey Mine. Owner, Pacific Portland Cement Co. Cons., San Francisco. It is one mile north of Carbondale, the nearest railroad point, to which a spur track could be run with practically no grading.

The lignite has been partially developed by a vertical two-compartment shaft 88 feet deep, with drifts driven north and south in the nearly horizontal bed. The mine has been idle about ten years, and the workings during that time have been flooded and inaccessible, but the coal is said to have a maximum thickness of 20 feet, and the total length of drifts is reported to be 1000 feet. The material on the dump shows the form of fragments of trees from which the lignite was derived.

There is an old building housing a 60-h.p. steam boiler and hoist.

Mine No. 4 is one mile southeast of Carbondale, and one-fourth mile north of the Southern Pacific Company's railroad, with which it is connected by tram. It was formerly worked by the Ione Coal and Iron Company, being the last of a group of mines they operated. It was last worked in January, 1920. It is part of Rancho Arroyo Seco, a Spanish grant containing 33,000 acres, which is reported to belong to Stephen Kieffer, 57 Post Street, San Francisco.

A bed of brown lignite, seven feet thick, and lying nearly flat, has been opened by a vertical shaft 85 feet deep. Previous to 1920 it was worked by several thousand feet of drifts, leaving pillars. Coal was mined entirely by hand, and hoisted in cars on a cage, then sent down an incline to railroad cars. When last worked, 500 tons a month was produced and it was estimated that two years' reserve was left in the mine.

The above are only the latest worked of many lignite mines in the district. The numerous reports of the State Mining Bureau listed below contain descriptions of the different old workings. In the vicinity of Lancha Plana, which is just north of Mokelumne River, several small coal mines were worked during the '80s, but only a few tons were mined, due to the cost of getting it to market. The present owners of the land in this vicinity where coal occurs are *Penn Chemical Company* and *James Moore Estate* (John Moore, Stockton, W. D. and W. M. Amick, Mr. and Mrs. D. S. Mason, all of Ione).

In the Ione and Carbondale districts the only recent development has been the drilling carried on in 1923 under the direction of John Mocine on the Rancho Arroyo Seco. The holes showed that the lignite lies from 15 to 40 feet below the surface on the east near Lignite siding, and 3000 feet westward it is 81 feet deep. A number of holes indicated coal 21 to 30 feet thick, of which 12 feet are classed as 'heart coal,' of good quality. The deduction from this drilling was that either the ancient basins in which the lignite was deposited were larger than first thought, or that the lignite is now in the form of monoclinal strata. Previous government tests of the lignite, indicating a high oil content recoverable by destructive distillation, were reported by Mocine to have been substantiated in tests of his samples.

Analyses of Lignites from Amador County.

<i>Property</i>	<i>Volatile Hydrocarbons %</i>	<i>Fixed Carbon %</i>	<i>Ash %</i>	<i>Moisture %</i>
Mine No. 3 ¹	49.00	27.75	10.50	13.25
Newman Ranch ¹	37.75	38.50	8.75	15.00
Mine No. 3 ² (4 samples)	33.35 to 42.4	11.85 to 34.3	9.25 to 47	7 to 14
Orr Mine ² (Lancha Plana)	47.75	20.05	24.25	7.5
Wardell Mine ¹ (Lancha Plana)	34.00	28.75	22.00	15.25
Buena Vista Mine ³	22.75	39.8	8.35	28.00

Bibl: Cal. State Min. Bur. R. IV, p. 268; VI, p. 116; VII, p. 150; VIII, pp. 109, 113; IX, p. 323; XI, pp. 146, 148; XII, pp. 40, 65; XIII, p. 51; XIV, p. 11; XVII, p. 413. U. S. G. S. Folio Reprint 3, 5, 11. Min. Res. of U. S. West of Rocky Mtns. 1874, p. 43, R. W. Raymond.

COPPER.

There has been no renewal of activity at any of the old copper mines, which were described in Report XIV of the State Mineralogist, and in Bulletin 50.

Geologically the copper mines of the county are similar to the others in the foothill copper belt. They occur in the large area of amphibolite schist which traverses the county in a northwesterly direction, passing 2½ miles east of Ione and continuing into El Dorado County at Latrobe.

The most important of these mines were the *Copper Hill Mine* in the northwest corner of the county and the *Newton Mine*, four miles east of Ione. Both of these, and probably all of the small copper prospects in the county, were discovered in 1862 and 1863, during the state's first copper boom, and produced a few hundred tons of good ore before the boom collapsed in 1867.

Copper Hill Mine was developed by two principal shafts, one 500 feet deep and the other 144 feet deep, on parallel veins called the Oriental and Cosunnes, from which a distance of about 550 feet along the strike was explored by drifts. This property forms part of a large holding now devoted to stock-raising.

Newton Mine was worked to a depth of 430 feet and is said to have made a total production of 33,000 tons. During 1900, 3500 tons of 7 per cent ore was produced. This was the last production.

¹ Cal. State Mining Bureau R. XI, p. 147.

² Cal. State Mining Bureau R. XII, p. 65.

³ Private analysis.

Bull Run Mine had a shaft 400 feet deep and was a small producer in the '60s. It is in Sec. 15, T. 5 N., R. 10 E., three miles east of Buena Vista.

The old *Ione Mine*, three miles north of Ione, has one shaft 600 feet deep and another 235 feet deep. Two short oreshoots of good grade were found and produced some ore reported to have yielded 7% copper, \$8 gold, and some silver and zinc.

For the most part, the other prospects are now included in large holdings devoted to stock-raising. Notes on these are to be found in the reports mentioned in the first paragraph.

GEMS.

Mooney et al. Chrysoprase Claims. L. Mooney, Henry King, Wm. Yerington and F. R. Bequette, all of Ione, have located two claims for chrysoprase about six miles southeast of Ione.

The chrysoprase, of a bright green color, occurs as a seam an inch to 1½ inches wide in serpentine. It has been opened at intervals by shallow holes only, for about 400 feet. Samples of the stone so far found are perhaps seamed and laminated so much as to permit cutting only rather small pieces, but it may improve with depth. Idle.

Chrysoprase is a variety of chalcedony colored bright green by nickel.

GOLD (QUARTZ MINES).

The Mother Lode is one of the most interesting, and has so far proven to be the most persistent in depth of the gold-bearing formations of the United States. Of all the mines opened along the course of this lode, those of Amador County, taken as a group, have been the most productive. Opened on the dip of the vein to a depth of a mile, equivalent to 4500 feet vertically, they still carry profitable ore with most of the gold free, and without radical change in the nature of the orebodies. Increasing cost of operation, incidental to increasing depth, and the difficulty of holding the ground open, will eventually prove the factor limiting the operations, because that which is ore at shallow depth can no longer be handled at a profit even at the depths already reached in several of these mines.

The term Mother Lode has been loosely used and is associated in the minds of many people with a large territory, including indiscriminately all of the gold mines east and west of the main lode. While it may be true that most of the veins in this wider area are of about the same age, they cannot be grouped together because of wide differences in their characteristics. Strictly speaking, the Mother Lode in Amador County comprises the series of similar but not always continuous quartz veins in the comparatively narrow belt of Mariposa (Jurassic) black clay slate, the intensely altered igneous dikes or flows which are found in the slate, and the altered igneous rock originally andesite or diabase (but in many places adjacent to the lode changed to amphibolite schist by pressure), forming the immediate walls of the Mariposa slate.

The Mariposa slate was originally deposited in the form of mud on an ancient sea bottom and the occasional lenses of conglomerate indicate the old shore line. Volcanic tuff of the same age as the slate is often



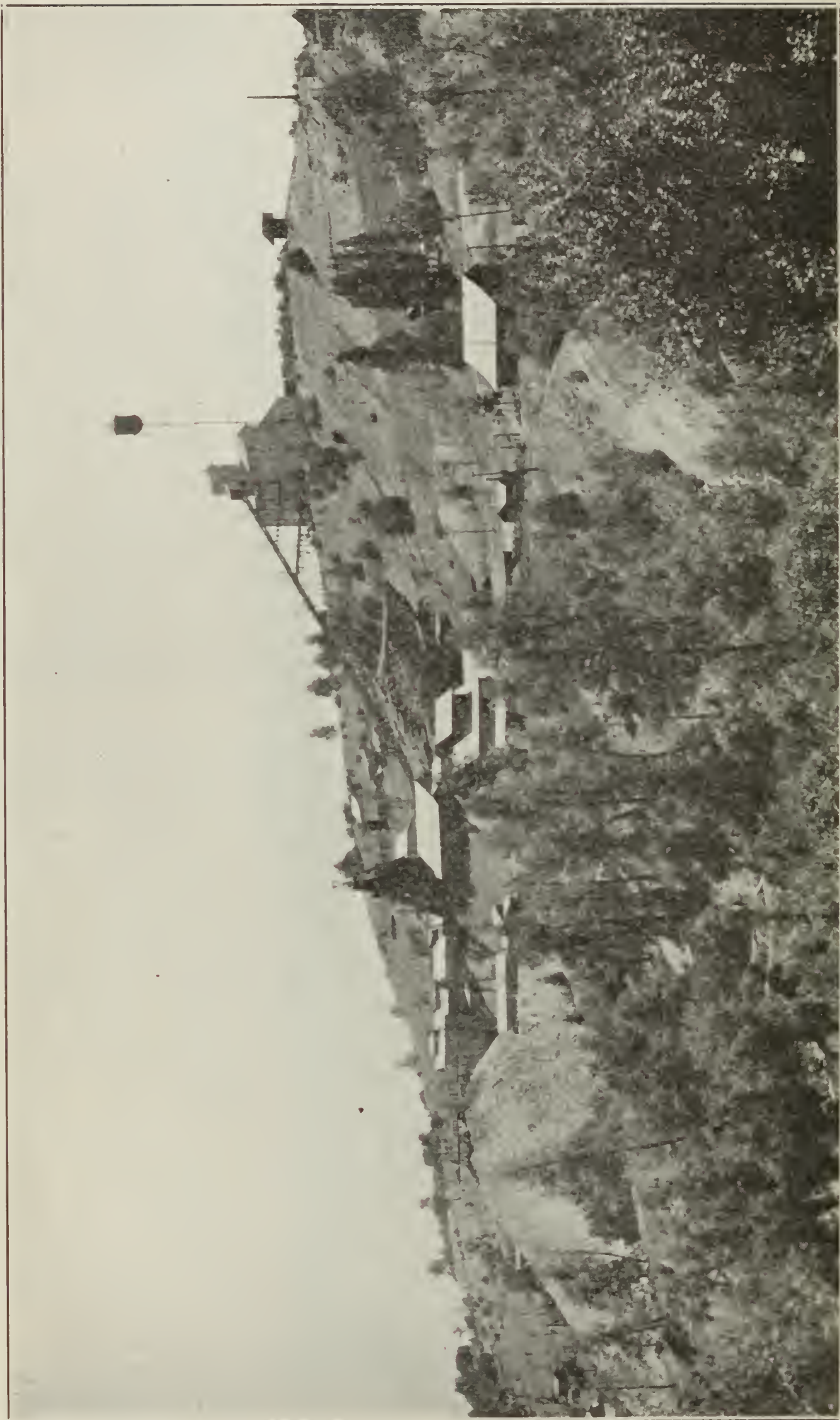
A view of the Mother Lode, Amador County, showing, in foreground, the Bunker Hill Mine; in center, Treasure Mine, and in background, left, the headframe of the Fremont Mine.

found in it. The Calaveras (Carboniferous) schists sometimes are closely associated with the slate, and may be confused with it if the exposures seen are small, but are generally harder, more micaceous and vary in color. The Mariposa slate is the weakest rock of the region, lacking elastic strength entirely.

The principal component of earth forces in this region has been exerted in pressure at right angles to the axis of the Sierra Nevada, to which axis the strike of the schistosity of the slate is parallel. After the shale had been changed to slate, or while being so changed by the tremendous pressure, overturned folds were formed in many places and when these folds were broken the hanging wall portion was thrust up over the footwall, giving a reverse fault; a pre-mineral strike fault system was formed in this way which has determined the strike and dip of the Mother Lode veins. Oblique faults have cut across the lode in several places, dividing it into large blocks. There has probably been rotation within the blocks, with subsidence also on the hanging wall side, all facilitated by the formation of the blocks. It is not believed that this system of strike faults was reverse everywhere on the lode. Probably in places it was normal faulting. If not, the subsequent subsidence of the hanging wall in some mines has been enough to mask the previous movement. Movement northwest along the strike fault is indicated by the pitch of some oreshoots in that direction. Movement has continued at intervals over a long space of time, as shown by the occurrence of 'ribbon rock' on the footwall side of the vein, and by the cutting off of ore with low-grade 'drag' along the fissure. Some of the oblique faults have cut off ore.

Another consideration is of interest in connection with the location of oreshoots. When a soft, weak rock like the Mariposa slate is subjected to great pressure and movement occurs, the result is a finely ground, putty-like mass of gouge. This forms a natural dam in the fissure, and is relatively impervious to solution by the vein-forming fluids. There is little mineral deposited in such places unless there has been repeated opening of the fissure and intense action such as might occur with cross faulting. But where the fissuring has passed alongside or through a harder rock like the meta-andesite or amphibolite schist, and the inequalities and movement leave open spaces, these harder rocks will support an open cavity in which ore may be deposited. The harder wall rock and the quartz vein that grow up beside it are much more resistant to erosion than the soft, crushed slate. Hard walls, close together, will confine the auriferous solution to a narrow path, resulting in the deposition of richer ore. These considerations will explain why the oreshoots so often occur with a 'greenstone' dike for one wall or nearby in the hanging wall, and why the high land along the lode is commonly said to be most favorable for an oreshoot. The association of the vein and the hard rock is seen to be due to mechanical reasons. The gold came no doubt from a much deeper seated source, probably the underlying granodiorite. The carbon in the slate has probably been an active precipitant of the gold.

'Caunter' veins, occupying some of the earlier oblique faults, cross the lode and at times important and rich orebodies were formed at their intersections with the main fissure. The quartz forming the ribbon rock along the footwall side of the vein is generally richer, showing



Argonaut Mine and Mill, near Jackson, Amador County.

that the earlier vein-forming solution to invade the fissure was the richer, as might be expected.

Schist ore was formed where the soluble minerals of the amphibolite schist were taken in solution and disseminated gold-bearing pyrite was deposited in their place. Although some very rich ore was found in the schist in the form of pockets, this ore is generally lower grade than the quartz veins in the slate.

Quartz is the principal gangue mineral of the veins in the slate. Free gold forms 80% to 85% of that recovered from these veins. The remaining one-fifth or one-sixth of the gold occurs with sulphides, composed almost entirely of pyrite, with galena as a characteristic of high-grade ore. In several mines small, rich stringers carrying arsenopyrite have been found, and orpiment has been mentioned. Tellurides in small quantity have been noted. In this kind of ore, the sulphides form $1\frac{1}{2}\%$ to $2\frac{1}{2}\%$ of the ore, and range in value from \$50 to \$120 a ton. In the schist ore, the sulphides form 3% to 5% of the ore and carry five-sixths of the gold.

Argonaut Mine.

History. Work began on this property in 1850, but was prosecuted on a small scale and in a desultory way until 1893, under the name of the Pioneer Mine. This work was mostly through an adit on the northern end of the Pioneer claim. While the Kennedy was being actively worked the Pioneer lay almost undeveloped for many years, and is said to have been offered to the Kennedy owners several times at the nominal price of \$30,000. They evidently did not consider it worth the price. In 1893 an inclined shaft was started. When this had reached a depth of 1750 feet work was stopped in 1900 by an injunction issued during a suit started by the Argonaut company against the Kennedy. The Argonaut owners were forced to prove their vein continued through to the apex in their own ground. As the shaft was not on the vein, they were obliged to complete raises the entire distance and after thus having proved their apex, they were awarded heavy damages against the Kennedy. The Argonaut also successfully contested a suit at a later date with the Kennedy Extension Mining Company, on the south.

The Argonaut continued operation thereafter until the spring of 1919, when fire, thought to have been of incendiary origin, was discovered on the 4000-ft. level. In this period the mine workings had reached an inclined depth of 4800 feet, on an incline of 63° . The property between 1914 and 1919 had been producing the best average grade of ore of any mine along the Mother Lode, the mill-heads having ranged from \$8 to \$11 a ton. Within a short time the fire was thought to have been surrounded and brought under control, and work was resumed. But early in March, 1920, fire was discovered on the 3300-ft. level of the adjoining Kennedy Mine, having presumably eaten its way through old workings and caved ground. On March 17, 1920, the Kennedy management began filling that mine with water, and as the two mines were connected, the lower levels of both were flooded and the water rose to within 50 feet of the 3150-ft. level of the Argonaut. Unwatering began at the Argonaut early that summer, but they found the task too much for their plant alone and the Kennedy joined in the

work, which was completed in April, 1921, and 20 stamps of the Argonaut mill were started that month. By the end of 1921 operations were in full blast.

The mill-heads in January and February, 1920, had been probably higher grade than for many years past, and although there was a dropping off in the general average of ore after this reopening, the work was going ahead under encouraging circumstances on the 4800-ft. level and the 60-stamp mill was being operated, when on August 27, 1922, at 11.30 p.m., a fire was discovered at about 3350 feet in depth by a party going up on the skip. A shift of 47 men at work on the 4650- and 4800-ft. levels was trapped and before they could be brought out the shaft was on fire and all of them were lost.

The mine was not completely cleared and ready for operation again until July, 1923. It has remained in steady operation since. The shaft has reached an inclined depth of 5350 feet (4672 feet vertical). Stoping has lately been going on from the 4950- and 5100-ft. levels and the 5250-ft. level is being opened.

Production. Unlike most of the other well-known mines along the lode, the Argonaut (Pioneer) was not mentioned in the early reports, and its deeper development came only at a comparatively recent date. Argonaut Mining Company reports that the total production of the mine to the end of 1926 has been \$12,400,000. This bureau's record of the tonnage of ore milled goes back only to the beginning of 1913. Since that time a total of 914,466 tons has yielded \$7,702,705. The bonanza period of the mine was between 1914 and 1920, when the ore was coming from the levels between 3400 and 4800 feet. Since 1921 the average grade of ore has been much lower than for the seven years preceding 1921, since which year most of the ore has come from levels between 4650 and 5150 feet inclined depth.

Geology. The geology of the upper one-third of the mine was described by W. H. Storms,¹ who called attention to the fact that the vein occupies a fissure apparently opened by a reverse fault in which the hanging wall had been thrust up about 125 feet, as indicated by the displacement of the Mariposa slate in the raise from the 470-ft. level to the old Pioneer adit. Here should be mentioned the contention raised by the Kennedy Extension Mining Company in their suit with the Argonaut company. About 1200 feet in depth on the Argonaut fissure, a vein branched into the hanging wall. The Kennedy Extension contended that this was the older vein, which had been displaced 700 feet by normal faulting as measured along the Argonaut fissure. The upper part of the vein to a depth of 290 feet is in the altered greenstone, which has been classified as diabase by H. W. Fairbanks² and as meta-andesite by the U. S. Geological Survey.³ This rock has been changed to amphibolite schist near the vein. The vein crossed a narrow belt of Mariposa slate about the 470-ft. level, and from there to about 2500 feet in depth was about on the contact, with Mariposa slate footwall and amphibolite schist hanging wall. For most of the remaining depth, the footwall country rock is hard gray schist, but with a casing of black slate between it and the vein and the hanging wall is Mariposa slate. Where seen on the 4800-ft. level, the slate casing on the footwall

¹ Cal. State Mining Bureau, Bulletin 18, pp. 56-60.

² Cal. State Mining Bureau, Bulletin 18, p. 17.

³ U. S. Geological Survey, Mother Lode Folio, No. 63.

was 10 feet thick, but in places is 20 to 40 feet thick, varying with the weaving courses of the footwall contact and the strike of the vein. On the 4350-ft. level the vein strikes N. 18° W. and dips 63° northeast, with slips in both the walls about parallel to the strike of the vein, but those in the hanging wall slate dipping about 80° northeast. On the 4500-ft. level the footwall contact strikes N. 20° W. and dips northeast 60° to 63° . On the 4800-ft. level the shaft crosscut to the vein crosses a pronounced slip with hard, blocky gray schist on the hanging wall side and slate on the footwall. This slip is 125 feet east of the true footwall, strikes N. 30° W. and dips 75° northeast. The vein, close to the footwall, has the normal strike of about N. 18° W. and dips 60° northeast. To properly correlate the geology of the Argonaut and the neighboring Kennedy on the north, it should be remembered that the Argonaut has the main footwall vein only, while in the Kennedy the breaking away of an immense horse of rock led to the formation of a hanging wall vein also. Dikes of greenstone, entirely altered to schist, occur within the Mariposa slate and on certain levels, as a result, the immediate hanging wall is greenstone and the footwall slate, as on the 3700-ft. level.

On that level the fissure was seven to ten feet wide and was one-half filled with gouge. Between the 3600- and 4200-ft. levels, because of its north pitch, the north oreshoot was in the Kennedy, then returned to the Argonaut. On the 4200-ft. level the vein was 20 feet wide; on the 4350-ft. level it was 30 feet wide, and continued wide in the south drifts in the deeper levels. Though most of the earth movements have resulted in crushing the slate, the footwall schist is in places shattered, and traversed by numerous quartz veinlets and occasional slips about parallel to the main vein, the schist being reduced nearly to gouge along these slips. The complete tracing out of the faults in this or any of the other large mines on the lode would require careful study at frequent periods over a number of years as the development work went on. Besides the pre-mineral strike fault of the lode, and the accompanying slips, there has been an important oblique fault in the Argonaut property, and post-mineral faulting within the vein. The 4500-ft. north drift 150 feet south of the Kennedy line showed the vein 15 feet wide with a width of six feet next the hanging wall dragged down. On the south on many levels the ore had been bounded by the oblique fault mentioned. This strikes northwest and its trace on the plane of the vein dips 70° to 75° northeast, judging from the positions where it was encountered on many levels. On the 4500-ft. level, about 200 feet south of the shaft crosscut, there was a length of about 200 feet of broken and crushed ground as a result of this fault. On the 4650-ft. level, the vein was stoped 480 feet in length when the crushed ground was encountered. This extended for 75 feet, and ore was found south of it, showing, when visited, 25 feet of quartz of which the hanging wall part was solid white quartz, with the best ore consisting of a few feet of ribbon rock on the footwall side. On the 4800-ft. level the vein widened rapidly south of the region where the fault had been found on the levels above. From a width of a few feet on the north, the vein increased in width to 60 feet on the south, and there was stoped 30 to 60 feet wide. The stope length on this level was over 1000 feet. On the 4950- and 5100-ft. levels the vein is reported much

narrower, and the oreshoot has apparently shortened and become flatter, approaching the shaft, which is in the hanging wall of the vein. The manager reports also a lower average grade of ore and ground increasingly hard to hold open, resulting in an operating loss in 1926.

Formerly, the mine was worked with a square set timbering system in the wider parts of the vein and stulls in narrower places. Since Harry Sheafe became manager, modified vertical slicing has been installed, following experience with caves on the 4500-ft. level. The method consists of driving a double-compartment raise in ore between levels. From one side of the raise, starting from the upper level, a stope is started by carrying down a vertical slice, dropping ore through one compartment of raise. The horizontal stulls are supported by booms of 10-inch by 12-inch timber, 16 feet long, extending out from the raise, and the timbering of successive sets is completed by the addition of posts as the slice is carried down. When a pair of slices, each about five feet along the strike, have been carried clear through they become the working compartments, replacing the original raise, which can then be stripped and filled.

Ore and Milling. The ore has remained free-milling at the great depth reached. It contains about 2½% of sulphides, of which pyrite forms the larger part. The concentrate contains about 16% of the gold recovered and runs about \$100 per ton in value for the higher grade ore. Generally speaking, the best ore is within a few feet of the footwall, and is of a ribboned structure which indicates repeated reopening movements and filling along that wall. Specimen rock is found at times. Milling is done in a 60-stamp mill which has been crushing an average of 250 tons a day during the past three years, in spite of the difficulty of doing all work at such a depth with one hoist and one shaft. After stamping, coarse and medium pulp is concentrated on Deister tables, the balance passing to Dorr classifier from which the fines (overflow) goes to Frue vanners. The underflow (coarse) is reground and sent over the Deister and Frue vanners. All tailing and concentrate are cyanided by Amador Metals Reduction Company.

Round pine timbers are supplied from the eastern part of the county, a short truck haul distant. Square 'Oregon pine' pieces for shaft sets, etc., are brought from Oregon. Electric power is used throughout. About 200 men are employed (March, 1927).

Argonaut Cons. Mining Company controls Argonaut Mining Company, the local operating company, and is in turn controlled by White Knob Copper and Development Co. of New York. The first named paid dividends during the war period up to 1922. Argonaut Mining Company resumed dividends in 1925 when the 106th was declared, but passed their last dividend. Much of the profit that might have been realized in recent years was diverted to pay the expense of twice unwatering the lower workings and repairing them and the shaft after the fires. The company has made a good fight during the past seven years in the face of many adverse circumstances. During that time this and three others of the principal producing quartz mines have stood the brunt of the county tax burden and have been the principal sources of livelihood for the workmen and merchants of the county.

The mine's production has been entirely from the Pioneer claim, and prospecting work done in the attempt to open ore elsewhere than in the main footwall vein has been reported unsuccessful.

Bunker Hill Mine was found in 1851 and was worked intermittently until 1899, then continuously by Bunker Hill Consolidated Mining Company until late in 1922. This mine was noted for many years as a profitable producer, in spite of the low average grade of ore. During a period of 11 years, prior to September, 1916, it paid 123 dividends. The gross production was about \$5,000,000 and the total dividends between \$900,000 and \$1,000,000. At the time distribution of profits ceased the ore being mined was averaging about \$4 a ton. Costs kept increasing to such an extent that what was first an operation without profit, carried on for the sake of keeping the mine in shape, turned into a loss, and it became necessary to search for ore of better grade. From May, 1917, to February, 1920, mill operation was at half capacity or less and from then until the property passed to the new owner in 1922, little milling was done and most attention was given to a search for new orebodies in the black slate, but these were not found.

The mine was worked through a shaft 2800 feet deep, giving a vertical depth of 2382 feet, and from that level 1020 feet north of the shaft a winze 640 feet deep on an angle of 53° was sunk during the later prospecting operations, giving an additional vertical depth of 511 feet. The shaft is concreted for 240 feet below the surface. Levels were run at inclined depths of 200, 300, 400, 500, 600, 800, 1200, 1400, 1550, 1750, 1950, 2200, 2400, 2600, 2800, 3200 and 3400 feet. The shaft is about 550 feet north of the south end-line, and work in both directions has been carried far enough to connect with adjoining mines, the Treasure on the north and the old shallow Mayflower shaft (belonging to the Bunker Hill now) on the south. The greatest distances drifted north were 1750 feet on the 2400-ft. level and 1778 feet on the 2600-ft. level. To the south they drifted 550 feet. Numerous crosscuts were run. On the 2800-ft. level they also ran a crosscut 400 feet west to the contact.

The principal operations at this mine, as at most of those on the lode, were on orebodies in the black Mariposa slate at the meta-andesite contact, known here as the hanging wall vein. The footwall of this vein was the soft, swelling slate, and hanging wall greenstone (meta-andesite) although the wall rocks were in places both slate, or the footwall greenstone. The work between the 1950-ft. and 2800-ft. levels is on the hanging wall vein, and this same vein was being prospected in the winze workings below 2800 feet, where the hanging wall is hard meta-andesite, in places altered to amphibolitic schist. The ore in this vein is a black gouge ore with quartz stringers. This vein was stoped above the 2400-ft. level, where the orebody was of a maximum length of 800 feet and a maximum width of 10 feet, averaging five to six feet. There is still considerable low-grade ore left above the 2800-ft. level.

When the slate ore in upper levels was stoped out, the 'grey orebody' was found on the 1400-ft. level and was worked down to 1950-ft. level, but has not been prospected below. Where first found, it was 40 feet west of and about parallel to the Bunker Hill vein. It had a maximum length of 850 feet and average width of 30 feet, but was in places 125 feet wide. This ore was formed by the hydrothermal alteration of the

schist which had been derived from the andesite. The andesite occurs here, as at other mines in the district, in the forms of lenses, as well as in the large masses on either wall. At its northern end, this orebody entered the hanging-wall fissure. The schist ore was characterized by 2% to 4% of sulphides, mostly pyrite, which carries most of the gold. It differs from the slate ore, where most of the gold is free.

The mill contains forty 1050-lb. stamps, dropping 96 times a minute; 10 in. by 20 in. crusher, 5 Deister Overstrom tables, 24 six-ft. Frue vanners and a 5 ft. by 6 ft. ball mill for regrinding sand. The crusher required a 30-h.p. motor and the mill two 50-h.p. motors. After crushing with stamps and amalgamating free gold, the pulp was run over the Deister tables, giving the first concentrate, then sand was ground in the ball mill, amalgamated, and concentrate saved on the Frue vanners. The capacity is 200 tons a day. Tailing and concentrate were formerly cyanided. The concentrate averaged \$50 a ton in value.



Central Eureka Mine, near Sutter Creek.

Total operating cost when 'normal' conditions prevailed, in 1914 and earlier, was \$3.35 a ton. The grey ore, running about \$5.70 a ton, allowed a good profit at that time. The ore developed in the hanging wall vein to date of closing would scarcely have paid even under former conditions.

Central Eureka Mine.

History. This mine was discovered in 1869, and was called the Summit. A 'chimney' of ore found at a depth of 165 feet yielded about \$30,000, it is said. In 1871 there were two shafts, one 300 feet and the other 500 feet deep. One shaft finally reached 550 feet in depth and another 700 feet, when the company quit work. The mine lay idle thereafter until March, 1896, when Central Eureka Mining Company began operations.

The south shaft, 700 feet deep when the company started, was sunk to a depth of 1850 feet by the latter part of 1900, and a 10-stamp mill

was built. Writing in that year, W. H. Storms¹ stated that several short, narrow oreshoots were found at a depth of about 1000 feet, and that these increased in length and width until they formed one good-sized shoot in the bottom level. According to Storms, the vein as then revealed was "the most simple in geological structure of any extensively developed mine on the central lode. It consists practically of a single fissure cutting in strike and dip the black tufaceous slates and amphibolite schist which form its walls. The mine has certain peculiarities which are noticeably persistent. One of these is the firmness and regularity of the hanging wall. The wall is not absolutely straight in strike, but rolls more or less in a series of long swells. The gouge which is always found on the footwall side, also has a sinuous course, swinging toward and away from the hanging wall. When at some distance from the hanging wall, little or no ore occurs in the fissure, but upon its approach to the hanging wall, the long, lenticular masses of quartz, which constitute these orebodies, begin to form."

However simple the geology of the old upper workings may have appeared at that time, the geological conditions have been far from simple in later years.

The company operated with a good profit up to 1907, paying large dividends. The operations during this period were on the hanging wall vein from 1000 feet to 2500 feet inclined depth, and a little ore was also taken from the intermediate vein.

After closing in 1907 the mine was reopened in July, 1908, and work continued until the spring of 1913, but was then interrupted again from April to the end of that year. In 1914 another loss of six months' time resulted from caves in the South Eureka shaft. During this period the mine was worked at a loss. The ore decreased in value to below \$4 a ton and for some years averaged only a little over \$3 a ton. The shaft in 1914 had reached a depth of 2825 feet. During the next five years it was sunk to a depth of 3500 feet (incline). Only low-grade ore was found during this time, and many assessments were levied. The retiring directors in April, 1916, concluded the mine was exhausted, and wanted to quit. Conditions at the time appeared to warrant this. For several years the oreshoots had been shortening and of low grade. The plant was getting old, the shaft was bad and the skip was still being run on strap iron. Due to the convergence of the end-lines in the direction of the dip, the length of the holdings along the contact vein was shortening on each successive level. But fortunately for all the stockholders, the new board of directors decided to continue. C. E. Julihn reported on the mine and advised that the east and west country be explored, as the former work had been done in the central part of the lode. The new program was begun that year. Work was partly financed during this period by assessments, the returns from milling being insufficient to pay the operating costs. Early in 1919 the 3500-ft. level was reached. The shaft crosscut on this level showed signs of ore. On the north also, a good shoot was struck and was stoped on to the 3425-ft. level. In the north drift, a winze was started and at a depth of 85 feet below the level a winze level was turned and was drifted both ways, in fine ore. Other encouraging prospects began to be found.

¹ Cal. State Mining Bureau, Bulletin 18, p. 64.

The stockholders had now reached their 48th assessment, but at this point the mine was entering its bonanza period, and during the years since 1919 has richly repaid their tenacious faith. In the year ended April 22, 1920, a total production of over \$430,000 was made, the ore coming principally from the 3500-, 3600- and 3700-ft. levels, and averaging for the year \$13.15 a ton, with an extraction of \$12.40 a ton. Dividends began that year and have continued since. The lowest working level is at 4700 feet inclined depth or about 4360 feet vertical.

Geology. The lode belt at the Central Eureka is about 1600 feet wide, and is composed principally of Mariposa (Jurassic) black slate, in which occurs, in the westerly or footwall section, several dikes of andesite or andesite porphyry altered to schist. The series of rocks dips east at a somewhat steeper angle than at most places on the lode. Both walls of the lode are andesite (or diabase, as described by some authors). The veins so far found are in the westerly or footwall half of the lode. The principal vein worked in the earlier operations was the so-called hanging wall or east vein, which has an andesite dike for its immediate hanging wall. The oreshoot on this vein extended from about the 1000-ft. level to about the 2540-ft. level and apparently had its greatest stope length about the 1500-ft. level. It was one to twelve feet thick. Below 2540 feet in depth considerable stoping was done on the intermediate vein also. The upper part of the hanging wall oreshoot paid well, the ore averaging \$7.16 a ton up to 1905. While the record is not available, this must have come from above the 2500-ft. level entirely. The section from there to 3400 feet in depth on all the veins was low grade. In 1907 the ore was worth \$5.60 a ton, but still permitted dividends. From 1908 to 1919 apparently no dividends were paid. During this time the ore was in small scattered bunches and yielded an average of \$3 to \$4 a ton. The east vein was stoped from the 2500- to the 3000-ft. level. Stoping on the footwall vein started below the 2825-ft. level in 1914. On the intermediate vein, stoping was done between 2500 and 3200 feet. This oreshoot came in from the South Eureka line and pitched south, crossing the shaft at about the 3200-ft. level.

The shaft struck the hanging wall or east vein at 500 feet and followed it to about 2000 feet deep, where it passed into the slate in the footwall of that vein. It cut the intermediate vein below 2700 feet. About 25 feet below the 3425-ft. level the shaft entered the altered andesite and the 3500-ft. level and ore-pockets are in this rock.

Considerable prospecting was done both east and west of the shaft, especially after 1917. On the 700-ft. level an east crosscut was run 774 feet without finding ore. On the 1800-ft. level the footwall crosscut was run 717 feet through alternating slate and dikes, but no ore was found. Small lenses of good ore began to show in the footwall gouge on the 3350-ft. level. On the 3500-ft. level in 1919 a contact between slate and 'greenstone' (altered andesite) was struck 28 feet southwest of the shaft. They drifted south 215 feet along this contact, which carried two to five feet of rock and ore assaying \$2 to \$7 a ton, with some good assays. In this south drift a crosscut was run 30 feet west and cut three feet of fine ore. The main crosscut west from the shaft was in crushed slate and quartz stringers. At a point 33 feet west of

the 'greenstone' contact, in this crosscut, quartz showed on the north side and on being followed it proved to be a good oreshoot. From this north drift a crosscut northeast to the 'greenstone' contact failed to show ore, but about 30 feet farther north, another hanging wall crosscut struck a small oreshoot. It began to be realized that geological conditions were complex in the mine. It seemed unsafe to leave any block of ground unprospected, even when an apparently firm rock, with the appearance of a true wall, was reached. In the floor of the north drift on this level a winze was sunk and at a depth of 85 feet drifts were turned both ways. The first 50 feet on the north had an average width of 14 feet and assayed \$20 a ton; for 80 feet on the south it was even better. The ore here was ribbon rock, carrying pyrophyllite. This ore had increased from a width of two feet or less on the 3425-ft. level to 21 feet on the winze level, about 160 feet deeper. The low-grade ore previously milled had carried nearly one-half of the gold in the sulphides, but this richer ore has had five-sixths, or more, of its gold in the free state. A little gold telluride has been found. The ore has continued good in the lower levels and the shoot continued to increase in size. On the south it was more bunchy than on the north. On the 3700-ft. level on the south the vein was crushed by a vertical fault along the plane of the vein, which here cuts through the 'greenstone,' with the latter west of the drift. At this level the hanging and footwall veins are close together.

It is not practicable to discuss fully the geology of the mine in this quarterly bulletin. For a proper understanding of it, the South, Central and Old Eureka mine workings and oreshoots should be illustrated. Due to the convergence of the end-lines of the Central Eureka or Summit claim, toward the east in the direction of the dip of the vein, and the question raised as to the exact identity of the vein in which the new oreshoots had been found, the company found itself in an embarrassing position in 1923. The length of vein between the end-lines of the Summit claim, produced easterly, was rapidly decreasing. Fortunately, they were able at that time to reach an agreement with the owners of the Old Eureka for the purchase of that property for \$150,000. The contention of Albion S. Howe, superintendent of the Central Eureka, has been that the vein opened in the lower levels is not the same as that mined above 2540 feet, it being claimed that the vein in the old upper workings was a younger vein, which broke and faulted the older, and that the upper portion of the older vein lies to the east and outcrops on land controlled by the Central Eureka, although in the lower levels it is west of the east vein.

The footwall vein oreshoot on the 3760- and 3900-ft. levels is reported to have been 340 feet long and averaged nine to ten feet wide, filled with quartz ribbon rock and gouge. On the 3500-ft. level, ore had been in two shoots separated by 160 feet of low-grade filling, but in depth the south shoot pitched north and they joined. The ground had been stoped out on this oreshoot previous to April 1, 1926, down to the 4400-ft. level. When the writer visited the 4550-ft. level late in 1926 stoping was going on there, and the 4700-ft. level was being opened. On the 4550, a width of about 60 feet traversed by the shaft crosscut should probably be considered vein matter. North of this the vein is a stringer lead of crushed quartz and slate striking N. 40° W. and

dipping 71° E. and the orebody has an average pitch of 45° NW. in the plane of the vein. It is roughly wedge-shaped here, with the big end down. On the east side, a spur vein striking N. 25° W. makes into the vein at this oreshoot. This spur vein itself forms stoping ground for 165 feet near the junction. Above the drift on this, a very rich streak traverses the spur vein diagonally to the junction with the main vein. In cross section the following were seen: high grade quartz ore in black graphitic schist, probably a phase of an altered dike rock; on the hanging wall side of it, eight feet of quartz ore, and on the hanging wall side of this, the point of a 'greenstone' dike, 18 inches wide, separated from the ore by a small slaty gouge. On the east is more of the graphitic schist, which is a different rock than the Mariposa slate. The schistose andesite (amphibolite schist) appears nearby in the footwall. The high-grade quartz is finely crushed and may be rubbed to powder in the fingers. The whole vein is much disturbed and smashed. The high-grade streak enters the main vein about the center of 425 feet of stoping ground. The movements which crushed the quartz and slate are thought by Howe to have been a series of faults entering from the hanging wall side, as he says the footwall is unbroken, and all polished faces and slickensides are in the hanging wall portion of the vein. The high-grade occurs where the vein narrows. On the north and separated from the main orebody by 130 feet of blank ground, is a quartz orebody 80 to 100 feet long.

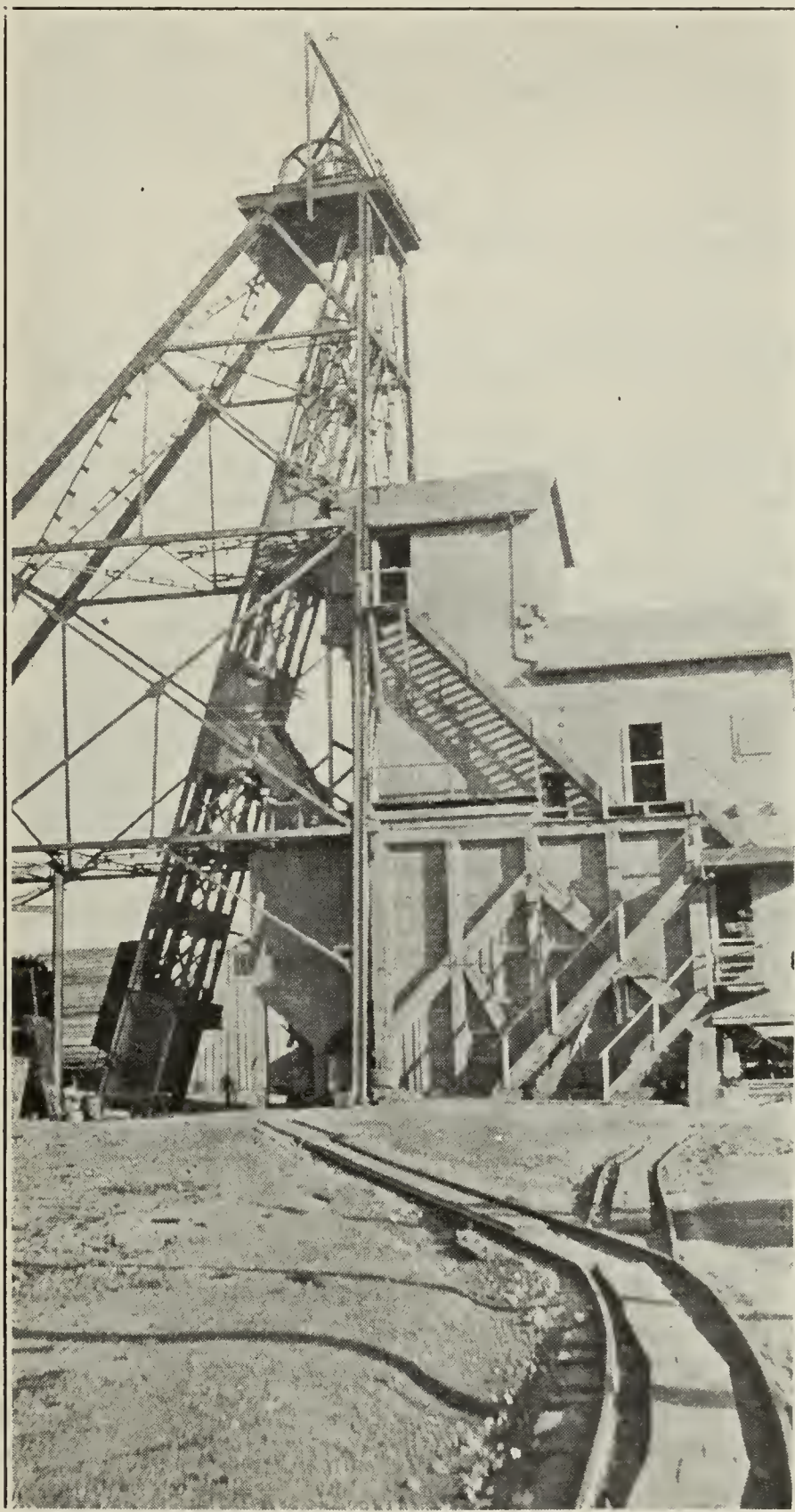
As greater depth is reached, the vein becomes more broken and crushed. This was noticed first on the south, but has reached the point on the 4550- and 4700-ft. levels where the slate is ground to gouge and the quartz to powder. Possibly this is due to an oblique fault of the same character as that described under the Argonaut.

Production. The total production by the present company from March, 1896, to April 1, 1927, was \$6,602,952. For the year ended March 31, 1927, 46,756 tons of ore were milled, which yielded \$551,108, or an average of \$12.85 a ton. The upper oreshoots, worked between 1896 and 1907, inclusive, yielded 287,175 tons which returned a gross recovery of \$1,911,358, or an average of \$6.66 a ton, although the average grade was higher for the period prior to 1905. From 1908 until early in 1919, and between the 2540-ft. and 3425-ft. levels, the material milled was for the most part too low grade to pay expenses. From 1920 to 1926 over half of the total production has been made and the ore has averaged \$10.58 a ton. The levels between 3425 and 4550 feet inclined depth have already yielded over 300,000 tons of ore.

Ore is crushed in a 40-stamp mill and concentrate is saved on Frue vanners. The mill showed an average capacity of 146 tons in 24 hours in 1924 and 152 tons in 1925. The recovery has ranged from 89.37% to 91.77%. Some loss is said to occur in fine, flaky telluride. The concentrate forms from 1.65% to 2.5% of the ore and ranges in value from \$70 to \$90 a ton. By far the greater part of the gold is recovered as bullion; only 14% to 20% of it is in the concentrate.

Many improvements have been made in the plant since 1920. The old strap-iron in the shaft has been replaced by 56-lb. rails and the shaft has been straightened and widened in places. A new steel head-frame 85 feet high has been built, a powerful hoist has been installed, and electric power substituted for steam, the mill repaired and many

other changes made. The conversion to electric power, besides giving greatly increased depth capacity, is said to give a saving of from \$1000 to \$1500 a month in the cost of hoisting. The importance to the county of an enterprise like this mine is realized when it is remembered that about \$200,000 was spent in 1925 for labor alone.



Headframe at Central Eureka Shaft, at Sutter Creek, showing skip runway in the form of a bridge truss.

Microscopic Studies and Analyses of the 'Greenstone.'

Through the courtesy of Albion S. Howe, superintendent, the following studies and analyses of the 'greenstone' (altered andesite) on the 3900-ft. level of the Central Eureka Mine have been made available:

*Report and Analyses by Phillip B. Wilson, Chief Geologist,
Calumet and Arizona Mining Company, Warren, Arizona.*

"The specimen marked hanging wall greenstone is more accurately a hornblende andesite porphyry. It is the fresher of the two. Its analysis shows 47.5% silica, 17.5% alumina, 8.0% lime, 5.7% iron, 5.0% magnesia, which would place it as a very basic andesite.

"The footwall greenstone is so highly altered that only remnants of the original rock minerals can be seen with a glass. It is a mass of kaolin and chlorite, with a little sericite and calcite, all secondary alteration products of original feldspars and of the ferro-magnesian minerals, hornblende and biotite. It was probably an andesite before it was so thoroughly altered. It shows many tiny disseminated pyrite and chalcopyrite crystals. An analysis yielded 47.7% silica, 14.1% alumina, 5.9% lime, 4.8% iron and 5.0% magnesia."

Report by Professor C. F. Tolman, Leland Stanford, Jr., University.

"Minerals distinguished under the Microscope (hanging wall greenstone) :

- (1) Feldspar, both acid plagioclase and orthoclase.
- (2) Quartz.
- (3) A ground mass which has been altered into kaolin.
- (4) Much pyrite, the result of hydrothermal alteration of the rock.
- (5) Also small amounts of pyroxene, augite and magnetite.

"The hanging wall rock is strongly porphyritic and in the specimen shining phenocrysts of pyroxene are abundant. Under the microscope pyroxene and plagioclase are recognized. These occur in an opaque ground mass which originally was probably a glass and is now altered.

"Under the microscope the rocks are seen to both be varieties of andesite. The footwall rock is much finer grained and less porphyritic than the hanging wall rock. It is more silicic in character than the average andesite. It has the texture of either a flow rock or an intrusive rock, more likely an intrusive."

Cooper Mine. It is a mile and a half by road northeast of Oleta. It was worked to a depth of 270 feet years ago by Cooper, and is credited with having been a good pocket producer. Later the workings are reported to have been lost on account of insufficient timbering. Only short drifts were run.

Defender Mine. Owner, West Point Con. Mines, Inc. Leased in 1924 to R. C. Reed, Volcano. It is five miles southeast of Volcano, near the West Point road.

There are three veins in granodiorite. The Defender vein is the middle one of these and the only one on which much work has been done. The main shaft, reported to be 480 feet deep, is on this vein, which is said to have averaged 20 inches wide. Levels were run at 100, 200, 250 and 300 feet and a maximum distance of 665 feet is reported to have been drifted, on the 200-ft. level. This work was done years ago and there was no opportunity to check it, or to observe underground conditions, as this part of the mine has been idle and workings were inaccessible at times of visit. The oreshoot was stoped at least from 250 level to the surface, and the production from it is reported to have been \$160,000. The oreshoot was reported wide on the 300 level, but only 100 feet long, and is said to be bounded by three dikes, one 100 feet north of shaft, another 80 feet south of shaft, and the third cutting the vein at 360 feet depth. In the lower workings the ore became so heavy with sulphides (principally pyrite), that it could not be treated, the sulphide content being too high for concentration, and the gold content about \$10 a ton.

In 1924, Reed drove a short adit and sank a winze 50 feet deep on the west vein. The quartz in this winze was six feet wide at time of visit, with hard walls and no gouge, and a poorly defined footwall. What appeared to be a dike was exposed on the hanging wall. Reed

reported that 11 tons mined here paid \$57 a ton. The ore of this mine, in common with that of the adjoining West Point district in Calaveras County, is complex, containing free gold and sulphides of iron, lead, zinc and copper.

Fremont and Gover Mines. The property covers 4200 feet along the Mother Lode, north of the Treasure Mine. There is little information available about the earliest history of the property. The claims in their order from north to south are: North Gover, Loyal Lode (east side), Gover and Fremont. The Loyal Lode had a 20-stamp mill in the '60s.

The Fremont and Gover were consolidated at an early date, and are described in early reports of this bureau, notably the Eighth, Tenth and Eleventh Reports, under the name of Gover Mine. The company was incorporated in 1872 and most of the early work was done on the Gover claim. Two shafts were sunk, of which the north one was the principal working shaft, and finally reached a depth 1500 feet (1050 feet vertical). Two veins were developed which were separated by a reef of black slate, sometimes only a gouge, but elsewhere 90 feet thick or more. Diabase, or schist derived from it, forms the hanging wall, as at neighboring mines. The contact vein, next to the diabase, produced the best ore mined. This ore was characterized by rich pockets of gold, and considerable arsenopyrite. At times the pocket stringers made into the diabase hanging wall. This shoot was about 200 feet long by 20 feet wide and pinched about 800 feet in depth, and a little deeper the slate receded, leaving the footwall vein on the contact for several hundred feet. Below this the East vein made into the hanging wall diabase. It was mineralized schist ore, had an average width of 30 feet and the low-grade oreshoot in it was nearly 300 feet long. This class of ore continued to the bottom. The lode in this mine was explored for 1100 feet south and 400 feet north of the shaft. At a distance of 1000 feet south of the shaft on the fourth level, the hanging wall fissure passed into the diabase of the hanging wall, and became a gouge seam. A drift on this soon struck a fault, which threw the formations west (looking south) evidently about 50 feet, the strike of the fault being a little north of east.

Early in 1900 the Fremont shaft was started. The mill was built in 1903. The upper levels, principally from 400 to 700 feet deep, developed the hanging wall slate vein and the pocket ledge, where rich stringers made into the diabase hanging wall. From the 800-ft. level downward the 'grey ore' or East vein of mineralized schist (derived from the diabase) was mined. Fremont Consolidated Mining Company worked until 1918 and reached an inclined depth of 2300 feet. The mine was closed in December of that year.

During that period a mill of forty 1000-lb. stamps and 16 Fruevanners was operated by the company, and the California Slimes Concentrating Company operated a canvas plant below the mill. The ore during the later operations was rather low grade, ranging around \$5 a ton. The mine was opened to a depth of 2500 feet on an incline of 51° and was prospected for a maximum length of 2500 feet on the 1650-ft. level.

Late in 1920, *Metals Exploration Company* began unwatering the property and it was prospected during 1921 and 1922. Early in 1923

the mill was repaired and 20 stamps were put in operation. The 1650-ft. level was extended northward to a distance of 2500 feet and prospecting was done on several levels below there. The company continued work until August, 1923, when it quit. Edwin Higgins and Roy Elliott, who had been employed by the company, and S. A. Holman, Elliott Check and W. E. Colby formed a new stock company immediately to continue the work. The mill was operated for a short time, and an attempt was made to finance further development work by selling stock, but evidently this was unsuccessful, as operations terminated in February, 1924, since which date the mine has lain idle.

The mine was opened to a depth of 2950 feet on 51° incline, and the lower levels were called the 1950-, 2350-, 2550- and 2750-ft. levels. It was said to be costing the owning company about \$5 a ton to mine and mill the ore, and it was nearly impossible to get labor when they quit in 1918. The 'schist ore' mined in the last operations was reported to carry from \$4.56 to \$7.50 gold a ton. Ore was claimed on the 16th, 19th and 25th levels in two separate oreshoots, one under the shaft and one 700 feet south of it. The south oreshoot on the 25th level was reported 125 feet long by 18 feet wide; on 23rd level, 160 feet long by 25 feet wide. The Fremont 'new orebody' had apexed on or near the 1500-ft. level on the contact of altered andesite hanging wall and slate footwall. It was 300 feet long by 12 feet in average width down to the 1650-ft. level and the millheads there are said to have averaged \$5.25 a ton. The operations by the last two companies apparently resulted in the development of little new ore.

The mill handled an average of five tons per stamp or 200 tons per day during most of the time under the owners. An average recovery of 85% was made by amalgamation and concentration on Frue vanners and the canvas plant saved about one-third of the remainder. Tailing was stored on the property.

In the last work by lessees a fictitiously low operating cost was claimed because of mining and milling ore developed previously, without taking account of the cost of developing it. The capacity, with 35 stamps in use, was raised to 215 tons a day, with about 80 men employed. Under such conditions ore carrying less than \$5 in gold a ton could be stoped, hoisted and milled at a profit. The concentrate went as high as \$105 a ton in value.

Hardenburg Mine, 3½ miles south of Jackson, was last operated by Hardenburg Mining Syndicate. This company quit work in 1917 because of disappointing results of their prospecting.

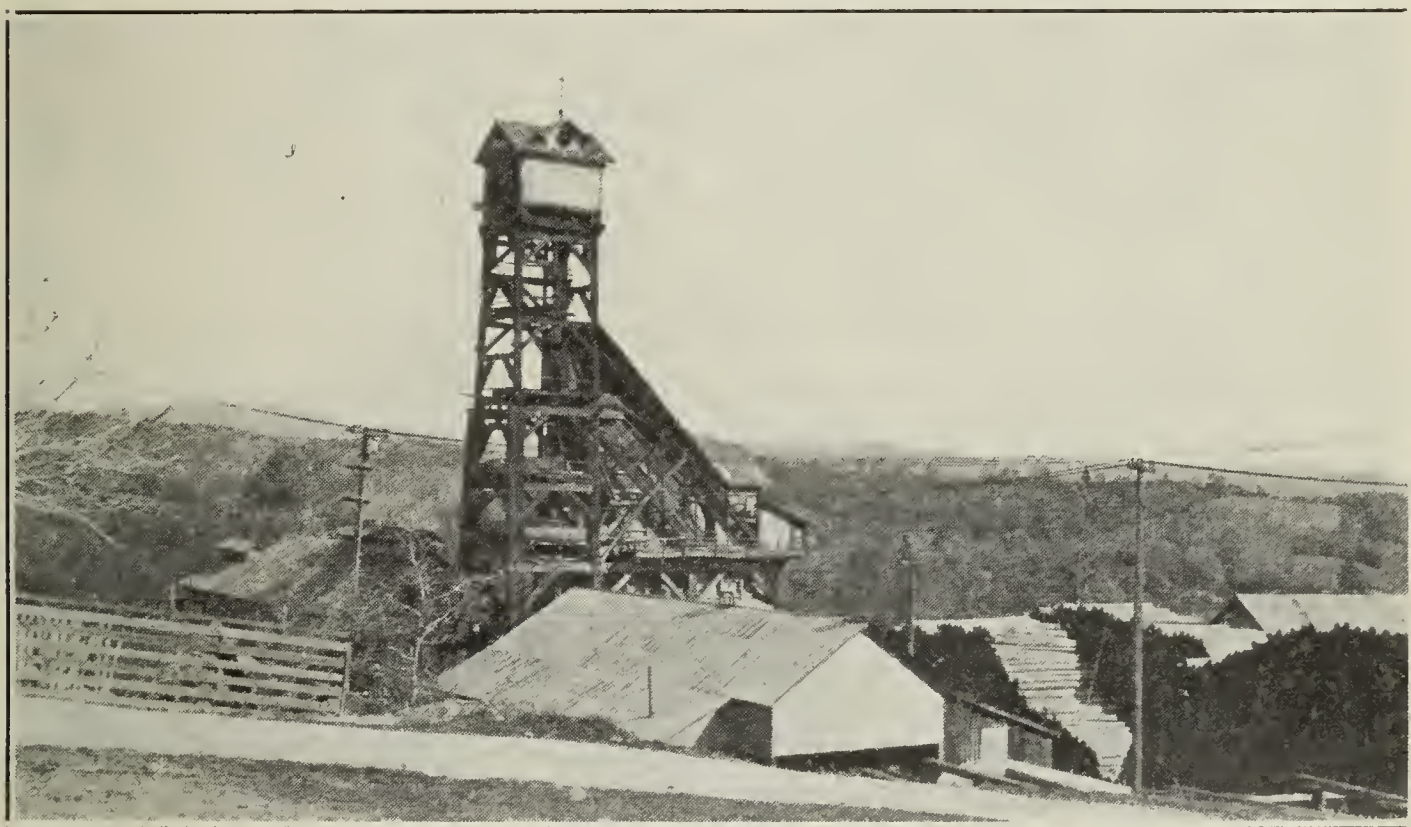
A three-compartment vertical shaft was sunk to a depth of 1500 feet, where it is reported to have struck the fissure. Above there, on the 850-ft. and 1000-ft. levels, crosscuts were run to the fissure, which is said to have carried low-grade material and a heavy gouge, making the ground difficult to hold open. There was a 20-stamp mill. In 1918 the surface plant was removed and the land sold for the benefit of the creditors, since when it has lain idle.

Kennedy Mine.

History. The Kennedy was opened previous to 1870, but until 1871 was worked on a small scale, with only a whim for hoisting. In 1871 the first hoist and a 20-stamp mill were erected. From then until

November, 1873, the production was \$183,427, or an estimated value of \$16.67 a ton. In 1873¹ two oreshoots were being worked. The Kennedy shoot on the north was 150 feet long and two to twelve feet wide, and the Pioneer (Argonaut) shoot was on the south end of the mine, 170 feet in length of it lying within the Kennedy property where it was 18 feet wide. The mine produced \$300,000 to a depth of 600 feet. At 750 feet depth in the south shaft the ore gave out though continuing in the Argonaut.

The Kennedy was shut down and lay idle until 1885, when the Kennedy Mining and Milling Company reopened it. The south shaft was sunk 200 feet deeper, and ore was found, and this shaft was continued on the incline to a depth of 2276 feet. The north shaft was also sunk to an inclined depth of 2500 feet. The results after reopening were so satisfactory that a new vertical shaft was started about 1900 at a distance of 1950 feet east of the north shaft, and intended to cut



Headframe and Timber Pile, Kennedy Mine.

the vein at a great depth. It struck the east vein at 3680 feet, the west vein at 4000 feet, and has been continued to a depth of 4612 feet.

Production. The Kennedy produced, to the end of 1915, and to a vertical depth of 3450 feet, a total of 792,000 tons, giving a total gross recovery of \$6,378,000, or an average of \$8.05 a ton. This shows that, as a whole, the property was a profitable producer during that time. Between 1885 and 1900 about 36,000 tons a year were milled, at a reported total cost of \$4.50 or \$5.00² a ton. For the period 1916 to 1926, inclusive, the production was \$5,991,530. This makes the total gross production of the mine to the end of 1926, \$12,369,530 gold and silver. Due to the low average grade of ore between 1918 and 1924, inclusive, when stoping was principally between the 3600-ft. and 4350-ft. levels, and because of the expense incident to unwatering the mine after the Argonaut fire in 1920, the operations for those years are alleged to have resulted in a large loss for that portion of this latter period. Since then,

¹ Raymond, R. W., Mineral Resources of the U. S., West of the Rocky Mountains.

² Storms, W. H., Cal. State Mining Bureau, Bulletin 18, p. 53.

the grade of ore has again improved enough to pay a profit. The cost in recent years is believed to have ranged from \$5 to \$6 a ton. The vertical shaft was designed to make it possible to work low-grade ore at lower cost, and this was possible up to the beginning of the war. At that time ore worth \$4 to \$5 a ton was being milled.

Geology. The workings of the Kennedy from 2000 to 3150 feet are partly in slate and partly in greenstone (altered andesite), but at greater depth are in Mariposa slate. A rather narrow greenstone dike lies close to the vein, but tapers down to a wedge and disappears at about the 3150-ft. level, as seen in cross-section. The fissures, while crossing the slate in the oldest upper workings, were barren or nearly so, but began to carry ore again on striking the greenstone on the east. The footwall country rock west of the lode is altered andesite, changed near the vein to schist. The total width of Mariposa slate is unknown, as it has not been crosscut in the Kennedy the entire distance. Between the footwall vein and the west wall lies a layer of slate varying from a few feet to 30 feet in thickness. On the hanging wall side there has usually been a heavy gouge, from four to ten feet thick.

Due to the breaking away of an immense horse of the hanging wall slate, an east vein was developed, beginning between 1700 and 2200 feet and extending to the bottom levels. This horse had roughly the shape of a double convex lens, and at its widest part separated the veins by a distance of about 150 feet. Both north of the shaft on the 3900-ft. level, and south of it on the 4300, the veins join, and finally on the 4500-ft. level the horse is reported to have disappeared, leaving a large vein with nine feet of ore on one wall, and 16 feet on the other, and a mass of lean bull quartz between them. The footwall vein, the same one mined in the Argonaut, has been the most important.

The best ore, taken as a whole, is the banded or ribbon rock, consisting of hard white quartz with numerous ribbons of finely ground slate and often ribbons of pyrite and galena, showing building up of the vein by repeated opening of the fissure and deposition of successive layers of quartz with 1% to 2% pyrite and galena. In the footwall vein, considerable light green pyrophyllite or similar talcose mineral occurs. In most of the specimens carrying coarse free gold, it has been noticed in association with this pyrophyllite, which is probably derived from the adjacent footwall andesite.

In recent years a distance of 1400 to 1600 feet along the strike has been explored on some of the levels, and two orebodies, one about 800 feet in length, were worked. For many years drifts were run northward from the shaft crosscuts on the west vein, and southward from shaft crosscuts on the east vein, with a system of crosscuts from each of these drifts to the other vein. The heavy slate and gouge have made square set timbering and waste filling necessary. Round timbers are bought in the eastern part of the county, and heavy square timbers of Oregon pine are brought from that state. The ore in recent years has ranged from \$4 to \$10 a ton.

The mill of 100 stamps and 42 Frue vanners has not been in full operation during this period, and has been shut down completely at times, as at the time of the first Argonaut fire, when operations had to be entirely suspended. Fire from the Argonaut ate its way into the Kennedy workings and the latter mine had to be bulkheaded and partly flooded in March, 1920, lying idle the balance of that year, and until

October, 1921. At present, 60 stamps of the mill are dropping, and about 250 tons of ore are crushed daily. The condition of the mine as regards ore prospects is more promising than for many years past, and the recent expenditures for hoisting plant changes were based on the results of development work since Webb Smith resumed the superintendency.

Electric power has lately been substituted for steam for hoisting. Since the Argonaut fire of 1922, a refuge chamber, accessible in time of accident from both mines, has been completed in an enlarged part of the connection between the 4600-ft. level of the Argonaut and the 3900-ft. level of the Kennedy.

Keystone Mine was discovered in 1851, opened in 1852, and the production up to 1867 was 44,000 tons, which yielded \$700,000.¹ From then on for many years the record of production is fragmentary. For the year ended July 31, 1868, it was \$155,522, average value \$12.86 a ton, the shaft at this time being 380 feet deep. In the next two years the production was about \$300,000 annually, according to contemporary estimates; in 1873, about \$400,000, and in 1874, 25,146 tons yielded \$452,507. From the surface to about 900 feet inclined depth, ore came from the 'contact' vein, lying in the black slate, with slate footwall and altered andesite hanging wall. According to an early description, "The ground in many places is loose, and the vein seems to have been subjected to great pressure, crushing the quartz to powder." At the contact there is a massive vein from 12 feet to 200 feet thick, but this rock was generally low grade. The pay ore occurred where side stringers made into the main vein from the footwall slate. These stringers dipped 47° east. Most of the mine's production came from this kind of ore from the surface to 900 feet in depth.

The massive low-grade or barren vein occurs on the hanging wall side of an important fault that has been traced for over 2000 feet and dips east 35° to 65°. This vein is composed of crushed fragments of the diabase and quartz. The banded ore on the footwall side of this was 25 feet wide in some of the stopes, and much of it was worked without timbers, and with few pillars. On the hanging wall side of the massive vein, and separated from it by a dike of diabase, a small vein was found in a strip of black slate. This carried arsenopyrite and pockets of gold, the largest of which was found between the 800- and 900-ft. levels and was reported to contain over \$100,000. Still farther west are other veins. The banded ore was stoped for a maximum length of 600 feet and an average width of 15 feet down to the 900 level, and gave out about 1200 feet deep.

The main or Patton shaft was sunk 2680 feet on 52° incline, being in greenstone from 1400 feet to the bottom. Below 900 feet in depth the fissure passed into the diabase, dipping flatter than the contact, and traversing the greenstone to a point somewhere below the 2100-ft. level, where it is presumed to strike the east slate. On the 1200-ft. level, 800 feet north of the main crosscut, a parallel oreshoot was found which was reported 130 feet long by 8 feet wide, of 'grey ore' assaying \$8 or more a ton. On the 1400-ft. level, 150 feet north of the main crosscut, the vein branched. A drift was run 650 feet on the west branch, which is reported to show ore eight feet wide at this place. A

¹ Browne, J. Ross, Mineral Resources of U. S., West of Rocky Mountains, 1868.

drift 270 feet long on the east branch was in low-grade material. The grey orebody pitches south, being 400 feet or more north of the shaft on 1400-ft. level and 600 feet south of it on the 2100-ft. level, where the orebody was 100 feet long and was mined for a width of 18 feet. The 'grey ore' is mineralized diabase (or schist derived from it) which has been changed by hydrothermal action, during which gold bearing sulphide, principally pyrite, was deposited, forming a disseminated orebody, in which most of the gold is associated with the sulphide, differing from the slate ore in which most of the gold is free.

On the 2100-ft. level, 1700 feet of crosscuts were run, and on the 2650-ft. level crosscuts were run to both contacts of the diabase, and several hundred feet of drifts were run, but no ore was developed on this level within the Keystone ground. A block of ore remains above the 2100-ft. level on the grey orebody. The owners estimate there are 200,000 tons of proven ore that will yield \$3 a ton; more liberal estimates have also been made.

Keystone Mining Company were the last operators and ran the mine and mill from 1911 until October, 1919. From early in 1915 until closing, 40 stamps were run, crushing about 7000 tons of ore a month. Ore averaged \$2.90 a ton, according to C. L. Culbert, secretary of the company. A small profit was made at times over operating costs on even lower grade ore than this, but the margin was small. The concentrate carried five-sixths of the gold and the freight and smelter charge on concentrate was equal to 42 cents a ton milled. The filling up of the tailing storage dam and inability to obtain additional storage space, as well as rising costs, hastened closing. The company has a good tailing storage site, but this would require either an elevator or the moving of the mill.

The total production of the Keystone is estimated to have been about \$17,000,000.

Lincoln Consolidated Mines include the Lincoln and the former Wildman and Mahoney holdings, there having been three separate mining groups originally, and containing in all 380 acres of mining ground with mineral rights extending from the north end of the Old Eureka property through the town of Sutter Creek to the Golden Eagle claim, a distance of about a mile along the Mother Lode.

History. The Lincoln was located about 1851, and the others about the same time. All three were worked during the '60s. The Wildman had a shaft 530 feet deep and a 12-stamp mill in 1867. It lay idle from then until 1887, when it was reopened by Wildman Gold Mining Company. The Lincoln had two shafts by 1867, one 669 feet deep and another 270 feet, and was said to have produced 3500 tons of ore annually from 1851¹ to 1867, except for two years. There was a 20-stamp mill and some of the ore was worth \$15 a ton. The Mahoney had been opened to a depth of 500 feet by 1873. The vein was 45 feet wide then. It had been profitable to a depth of 250 feet, but below there was in low-grade material. The early-day production from the Wildman to a depth of 500 feet, the Mahoney to a depth of 300 feet, and from the Hector portion of the Stewart is estimated to have been about \$1,500,000. The Mahoney was 900 feet deep when bought by the Wildman Company in 1894.

¹ Browne, J. Ross, *Mineral Resources of U. S., West of Rocky Mountains*, 1868.

The Wildman and Mahoney were worked by the Wildman Gold Mining Company until 1906, then closed down until 1908, when they were reopened and worked until 1911, since which year they have been idle. The Wildman shaft reached a depth of 1400 feet on 72° incline; Mahoney shaft, 1200 feet deep on 62° incline, and Emerson vertical shaft 616 feet. The Lincoln, after lying idle about 30 years, was reopened in 1898 by Lincoln Gold Mine Development Company. The three groups were taken over by the Lincoln Consolidated Mining Company after 1906. The Lincoln shaft reached a depth of 2000 feet on an incline of 63°. The Lincoln was not productive below the 400 level, but the Wildman was stoped to about 1400 feet and the Mahoney to 1200 feet deep.

Geology. The Mariposa slate between the Old Eureka Mine and Amador City is split by a tongue and smaller dikes of altered andesite and the mines of this company are grouped around the slate-andesite contact. The andesite (or diabase) has been in part altered to amphibolite schist. Going north from the Wildman the vein increased to 45 feet in width on the surface, and is said to have supplied much rich ore in the early days. It branched, or was split by a greenstone horse, at the north end of the Mahoney, one branch turning eastward into the Hector portion of the Stewart, with greenstone on the footwall, the other branch passing into the Lincoln with schist, and farther off, greenstone on the hanging wall. There was usually a heavy gouge, with ore at times on both sides of it. The ore in the Wildman and Mahoney was in the contact vein, along the schist-slate contact, in the upper levels. At depths reached in the earlier operations, namely about 500 feet deep in the Wildman and 250 feet deep in the Mahoney, the mineralization began to pass from the contact into the schist, where large bodies of low-grade altered schist, impregnated with pyrite, were found. The gray schist ore was on the footwall of the solid quartz vein. The wide section of rock on which mineralizing solution acted resulted in dispersal of the gold to such an extent that it was necessarily lower grade than if it had been confined to a narrow fissure. The schist dike was from 60 to 295 feet thick. Mining in the contact vein continued to the 1300-ft. level in the period between 1895 and 1899, the ore coming from that vein between the 500- and 1300-ft. levels and being of low average grade. In 1899 the development of small oreshoots found by diamond drilling in the schist dike began. As they had no dump room for waste on the surface, they milled everything that would pay for crushing, and the average grade was far below that needed to make ore, even at the low cost of operation.

After the Lincoln shaft was sunk to 2000 feet a drift was run south over 2200 feet, passing through the Mahoney claim and to a point under the Wildman 1400-ft. shaft. Long crosscuts were run into the footwall from the 500-, 1200- and 1950-ft. levels of the Lincoln shaft, and on the 1200-ft. level one was run into the hanging wall, all apparently without finding ore.

In the Wildman Mine, the north drift on the 1400-ft. level was run 437 feet and the south drift 666 feet. For a length of 250 feet on the north, the vein averages five feet wide, but the assay value is not known. In the south drift, according to information furnished from owners' records, ore began to make 193 feet south of the shaft and increased to 25 feet in width within 185 feet. A horse of ground had slipped into

the fissure here, causing a pinch in the vein for about 75 feet. Beyond this, the vein began to widen again, increasing from 10 feet just south of the horse to 100 feet wide at the face. This latter width was sampled in sections of five feet each, and the resulting average of the 20 samples was reported to be \$3.62 a ton. The general pitch of the Lincoln-Mahoney-Wildman orebodies appears to be southward, as is true also in the mines nearby on the south.

Production. There were three periods of production for these mines, of which the first was the production from the shallow zone to a depth of 400 feet in the Lincoln, 500 feet in the Wildman, and about 250 feet in the Mahoney. The exact figure for the total output for this period is unknown, but has been estimated at \$2,000,000 for the Lincoln (probably excessive), and \$1,500,000 for the Wildman and Mahoney, prior to 1887.

The Wildman Gold Mining Company started with a 10-stamp mill, which was enlarged to 20 stamps, then to 30. From 1887 to May 1, 1894, they produced from the Wildman Mine 94,206 tons of ore which yielded a gross output of \$417,561, after deducting freight and smelting charges on concentrate, and bullion refining charges.

From 1894 to October 1, 1901, they produced from the Wildman property 234,945 tons of ore of a total gross value of \$834,671, or \$765,347 after deducting for freight, smelting, etc. In the same period they produced from the Mahoney 269,681 tons which yielded a gross output of \$518,037, or \$439,471 after deduction of freight and treatment. Between 1895 and 1899, inclusive, the total average cost of mining and milling, including development and other improvements except enlarging mill, was \$2.59 a ton. During this time, the operations at the Wildman yielded a net profit of \$211,712. The operating loss at the Mahoney was \$144,040. Each mine was equipped with a 40-stamp mill, containing 750-lb. and 950-lb stamps. There is no record of the output between 1908 and 1911, but it is believed to have been small.

Lucky Strike (Moar Bros. or Pioneer) Mine. Owner, Mrs. Louise Cassinelli, care L. L. Patrick, Volcano. It is near Pioneer Station.

The geology of this region in general is similar to that of the West Point district in Calaveras County, adjoining on the south. The ore was stoped to the water level by former operators. An adit between 600 to 700 feet long early in 1927 gives backs increasing from 90 feet to about 400 feet as it goes farther into the hill. This passes under the old work. The principal oreshoot, according to Robert Duncan,¹ who recently examined and sampled it, is 180 feet long, 23 inches wide and of excellent grade. A second oreshoot, of low grade, was also passed through and indications of a third have lately been encountered. On the principal oreshoot, little has been done below the adit level to prove the downward extension of ore.

The property has been under option lately, but only a small crew has been employed.

Marklee Mine. Marklee Mining Company, 105 Federal Realty Building, Oakland, Cal. This company had cleaned out the first 230 feet of the old main shaft of the Marklee Mine and had done a good deal of work on the surface up to the middle of March, 1924, at which

¹ Mining Engineer, address Moore Mine, Jackson, Cal.

time they had suspended work. It is reported that over \$18,000 had been spent.

The main shaft, in which the rich shoot of early days was found, is about 500 feet deep. The strike of the vein is north of west and the oreshoot is said to have raked away from the shaft, necessitating longer drives on each succeeding level. The mine was discovered in 1868 and, according to a report by the original owners in 1869, was 100 feet deep the autumn of that year and was producing ore of an assay value of \$60 a ton, from which only \$30 a ton was recovered, on account of lack of facilities for saving sulphides. While the lapse of time has been so great that definite details are hard to get, it seems certain that the main oreshoot was quite short and that the bottom level had not been run far enough to prove the shoot, although a body of \$4 ore is said to have been found on that level. Besides the main shaft, a drift was run from near the shaft collar for about 800 feet along the vein, and three winzes were sunk to depths of 350, 100 and 140 feet, respectively. There is said to be about 200 feet of blank ground on the vein between the two oreshoots, the second of which is said to have been penetrated by the farthestmost winze, and is said to be about a foot wide. The mine is about five miles from Volcano. It is equipped with a 10-stamp mill, boiler and steam engines and small lumber sawing plant.

Later the company resumed work, finished unwatering and spent considerable money clearing and prospecting the old workings, but were unable to find the ore expected and work was stopped in 1926.

Moore Mine. This property had been idle about 35 years when a local stock company began the work of reopening in August, 1921. The old shaft below the water level was found in fairly good shape, but the fifth level, which had previously been drifted 400 feet in the heavy, crushed black slate in the main fault, was caved full. The shaft was sunk on an incline of 52° and this level is at an inclined depth of 435 feet. It was reopened, but did not carry pay. The black slate here is about 60 feet wide. In a fissure branching from the main fissure, and striking nearly due east into the amphibolite schist on the hanging wall side, a vein of quartz ribbon rock was found which carried four to twelve feet of ore. This gave such flattering prospects that a new 20-stamp mill and other buildings were erected and a tailing dam was built in 1922.

The mill crushed its first ore in October, 1922, but the first real mill run was for 23 days in December of that year, when 2265 tons milled gave an average recovery of \$6.35 a ton, with a high tailing loss. The great disparity between the previously announced assay values and the recovery was also partly attributed to stoping too great a width. As much as 32 feet in width was mined on the fifth level, including considerable schist which carried sulphides and proved to be low grade. The sixth (540-ft.) level was opened and drifted 213 feet northwest and 50 feet southeast, with ore for a length of about 100 feet. On the 640-ft. level, ore was stoped for a length of 300 feet and an average width of nine to ten feet, but at one place it was 16 feet wide where there was a sharp bend. During 1923 the mill operated 8½ months and the total production was \$118,274.

When the shaft was sunk to the 800-ft. level, it was found that the orebody had been faulted and a raise had to be put up and another

level opened at 750 feet to pick up the bottom of the upper section, which had a stope length of 250 feet and a width of four to twelve feet. The low-grade drag material in the path of the fault was milled. The shaft was continued during 1924 to the 1100-ft. level. Ore was found in the shaft at 1060 feet. On further sinking, it was found to be cut off at the 1200-ft. level by the contact fault, and work on the 950-ft. level showed it did not extend upward beyond there. The production during 1924 was \$150,243.

Early in 1925 a program of prospecting was laid out and begun. On the 1100-ft. level in the northwest drift, 500 feet from the shaft, some low-grade quartz was found, but did not develop into ore. The southeast drift on the 1200-ft. level was run to prospect the Zeila fissure. The total holdings of land meanwhile were increased to 580 acres under options. This prospecting work was continued during 1925 and 1926. The shaft was sunk to the 1800-ft. level (on 55° incline). On the 640-ft. level a fissure supposed to be the South Jackson vein was struck 770 feet west of the shaft and was drifted on 90 feet north and 150 feet south. It was only one foot wide and carried no ore here. Drifts on the main fissure on this level were run 220 feet southeast and 455 feet northwest without finding ore. On the 1800-ft. level a crosscut 170 feet northeast struck a vein supposed to be the Moore vein, which at that point was 18 feet wide and gave some good assays. It was opened for a length of 150 feet and was also found on the 1500- and 1650-ft. levels. It did not come up to expectations, although some ore was developed in it. On the 1800-ft. level, the main footwall gouge was followed north 1080 feet up to March 21, 1927, and is now in the South Jackson property. On the same date the west crosscut on this level, which crossed the supposed South Jackson fissure in January, had reached a length of 1120 feet, and was thought to be within 500 feet of the so-called Kennedy-Argonaut fissure. The shaft has reached a depth of about 2100 feet and will be continued to an inclined depth of 2500 feet.

The company reports a total production up to the end of 1926 of \$415,741, representing an average recovery of \$6.52 a ton. There has always been a large indicated tailing loss at this property, judging by the disparity between average assay values for mill-heads and actual recovery. Even after accounting for this disparity, which should be practically the same as the assay value of the tailing, there have been alleged losses variously ascribed to theft and to the presence of galena and orpiment in the ore. Both these minerals slime badly. Recovery has averaged 80% or less of indicated mill-heads.

The Moore plant has been the only complete one of any size erected along the lode in this county since the war, so the cost figures for the different items should be of interest.

COST OF PRINCIPAL ITEMS OF MOORE MINING AND MILLING PLANT,
ERECTED 1922-1924.

Mill, twenty 1200-lb. stamps, twelve 6-ft. Frue vanners, building, etc.----	\$50,072 00
Hoist building and hoist equipment (3000 feet depth capacity)-----	10,302 00
Headframe and equipment-----	7,902 00
Blacksmith shop and equipment-----	1,971 00
Timber shed and equipment-----	2,481 00
Tramway from hoist to mill (500 feet long, 2½-ton automatic side dump cars)-----	5,927 00
Underground equipment-----	13,167 00

From the sales of stock to finance the company's earlier operations, the sum of \$182,391 was realized. In 1925, Frederick H. Rindge paid \$150,000 for 1,971,372 shares, representing over 51% of a total of 3,629,606 shares outstanding. A large sum has also been raised by assessments, so that to date the operations have resulted in a loss. The company must be given credit for a persistent and courageous search for ore in the face of unexpected fault conditions which have upset all reasonable calculations.

Mountain King Consolidated Mine (Pitts). Owners, W. B. Pitts and Mrs. Louise Pitts, Pine Grove. In 1924 the property was under option a short time, and some preliminary prospecting was done by Alva S. Archer and associates, but disagreements led to abandonment of work.

There are two series of veins and rich ore has been found near their intersections. On an easterly striking vein a shaft has been sunk 265 feet, with a level at 250, but there is no record of production from it, though some good prospects were reported in sinking. About 150 feet north of this, a northerly striking vein comes in from the south up to the first fissure, and the Anaconda shaft was sunk 125 feet on this second vein near the intersection. This vein is said to have yielded a good gold production under romantic circumstances, but there is no written record. A tunnel was run from the creek 70 feet lower than the shaft collar, northward for several hundred feet, with two forks, and high-grade ore was found in both directions, on the north in a winze that was started by the last lessees and in an old raise put up by other operators. The veins in this part of the property range from one to six feet wide. Another vein, 250 feet north of the deeper shaft, appears to cut off the east striking vein. There are other veins on the property that have not been developed. The geological indications in the tunnel are promising, but it is evident that most of the work done heretofore has been in search of pockets and no attempt has been made to develop milling ore. The richer ore shows gold in galena.

The reported production was \$18,000.

Newman Mine. Owner, Fike Brothers. Lessee, Simon Shaw. On North Fork of Mokelumne River, one mile east of the Jackson-West Point road, in the West Point area of granodiorite. An adit has been run 800 feet, and good ore is reported in a vein one foot wide in a winze sunk 80 feet below this level. This winze is below the river level and water has caused trouble. A new adit is 70 feet long.

The property is equipped with a 10-stamp mill, four concentrators and air compressor, operated by water power.

North Star, McIntire, Boyson, Occident, Granite State and part of Beatrice claim were under option the past two years to California McIntire Mining Company for which Fletcher Hamilton was agent.

A shaft about 1000 feet deep on the North Star claim was unwatered to the 600-ft. level and considerable new work was done. The claims are on the Mother Lode north of Sutter Creek. The greenstone lies on the footwall, followed on the east by Mariposa slate containing the usual greenstone dikes. Most of the work was done on the North Star and McIntire claims. The old work on the North Star, besides the shaft, included a crosscut southwest on the 600-ft. level and a drift

2500 feet northwest on a gouge and scattered quartz seams in the slate in search of a possible continuation of the South Spring Hill orebody, which is said to have occupied the same fissure. No ore was found.

The new work included a crosscut 100 feet northeast to a contact of greenstone and slate with drifts 400 feet each way on the contact, which was found to be frozen and barren; the southwest crosscut was also extended 500 feet farther, making it 800 feet long. Here the footwall contact of greenstone and slate was prospected. Two gouge-filled fissures, 50 feet apart, were encountered. Going in a northerly direction from this crosscut for a distance of 550 feet, the face reached a point 180 feet from where the bottom of the 200-ft. McIntire shaft would have been, had this shaft been deepened. Southwest, these gouge-filled fissures were cut at several points, 400 feet of new work having been done in that direction. The gouge and black slate showed only small scattered bunches and seams of quartz, and Roger Beals, who was superintendent, stated that assays showed nowhere over a few cents in gold, although it had been claimed that there was a prospect in the McIntire workings, on the 200-ft. level. This work off the southwest crosscut prospected the McIntire ground for 950 feet. The work on the hanging wall contact first mentioned prospected that contact on the east side of the North Star claim for 800 feet. Three crosscuts into the greenstone, each about 60 feet long, developed nothing. The greenstone there is about 300 feet thick. The old drift, 2500 feet long, prospected the Boyson and South Keystone claims and a crosscut from it is said to have prospected part of the South Spring Hill claim.

Two conditions are noticeable in the workings on the 600-ft. level—first, the dryness of the ground, and second, the absence of any cross veins. The slate is plicated in small broken folds in places, and ground to gouge along the fissures with considerable quartz intermixed; but the very low reported assays indicate that the absence of ore is not due to faulting. The gouge has so completely dammed the fissures that although considerable water enters the shaft from the surface, and a small stream also runs along the lode, the workings are dry away from the shaft.

The company quit work about the middle of March, 1927.

Old Eureka (Amador Consolidated or Hetty Green Mine) has been purchased by Central Eureka Mining Company, which operates the adjoining property on the south. At this time, the Old Eureka is being unwatered, and the new owners were advancing one of their upper levels northward into the mine late in 1926.

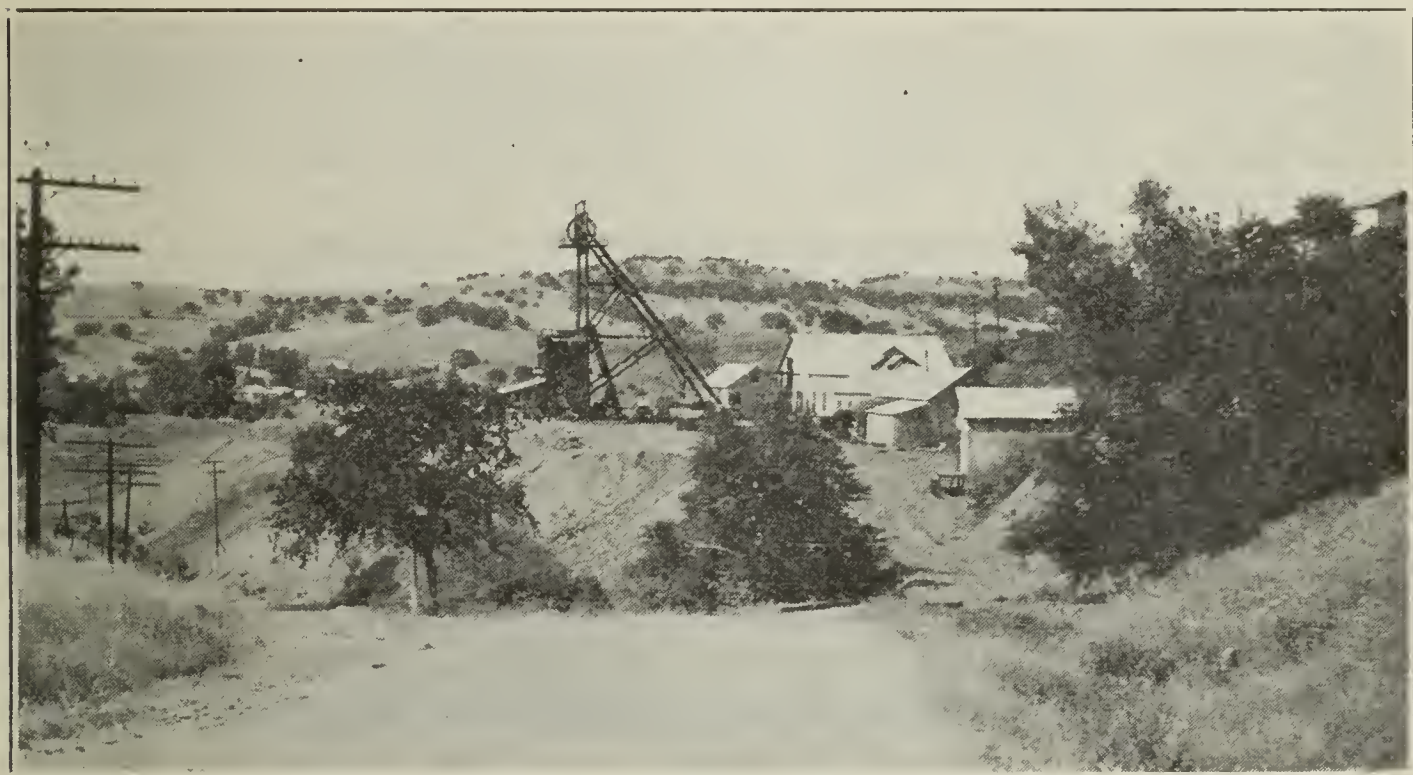
The Old Eureka was opened in 1852 and the first mill, of 10 stamps, was erected the same year on the Eureka claim. It was successfully operated until 1881, when work was stopped at a depth of 1965 feet. Two veins called the 'boulder ledge' and 'true ledge' were worked. The 'boulder ledge' was on the west and was 15 to 20 feet wide and yielded \$10 a ton, apparently having been of best grade between the 800- and 1350-ft. levels. The 'true ledge' varied from three feet to 15 feet wide in the middle levels and was of much higher grade. The richest part of the mine was apparently about 1000 feet in depth, where the ore averaged \$27 a ton. The oreshoot was 500 feet long, and was evidently bottomed between 1700 and 1800 feet deep. The ore value varied over wide limits; for example in December, 1872, it

averaged \$35.19 a ton, and in December, 1873, \$6.65 a ton, averaging for 14 months, \$17.91 a ton, recovered.

Total figures of the mine's production are not available but it is believed that \$12,000,000 to \$13,000,000 is a fair estimate, judging from known output for several years where exact figures are at hand.

In 1917, a well-financed company bought the property and unwatered it. The shaft was found in bad shape on account of having been sunk in the slate and about \$200,000 was expended for equipment, pumping and shaft repairs, the last two items alone amounting to \$117,657. The shaft was deepened to 3500 feet and levels were run north and south on the main vein fissure at 1700, 2125, 2950 and 3500 feet.

The main vein was found to have had a slate footwall with heavy gouge and greenstone (altered andesite) hanging wall in those workings that had furnished ore. The andesite extends for 800 feet on the strike, and the ore was stoped for 450 to 500 feet on the strike and



Old Eureka Mine, a noted early-day producer, with a yield probably in excess of \$12,000,000.

evidently cut out, both on dip and strike, with the thinning out of the andesite, about the 1700-ft. level. The shaft and most of the other workings between 1700 and 3500 feet in depth were in Mariposa slate, which is soft and swelling ground. The andesite lens thinned out to such an extent that it was no longer a factor in controlling fissuring, and the vein for the most part was a mass of barren or low-grade stringers in the slate between these levels. Wide veins of low-grade quartz were coming in at the south faces of the 2950-ft. and 3500-ft. levels. The former level was run to the Central Eureka end-line. A number of crosscuts were run without striking ore, although many think that the possibilities in this exploration of the walls of the main vein had been far from exhausted when work was stopped. The longest crosscut was 800 feet west on the 3500-ft. level. No ore of milling grade was found except a few small pockets.

The following are the positions of other veins with relation to the main Old Eureka vein:

Central Eureka lower (present) oreshoot is reported about 300 feet west of Old Eureka vein at the common end-line at 3500 feet in depth. Due to the direction of this end-line the length of the original Central Eureka claim along the strike shortened rapidly in depth. This vein was reported low grade where crosscut in the Old Eureka. As the later developments in the Central Eureka on this oreshoot have been principally below the 3500-ft. level and have extended to date to 4550 feet in depth, and several hundred feet north of their shaft, this is an example of the uncertainties of mining. The purchase of the Old Eureka prevented possible expensive litigation.

The Railroad vein is about 500 feet east of the main Old Eureka vein. It produced \$70,000 to a depth of 340 feet, the reported grade of ore being good.

The Wolverine vein is probably a little in the footwall of the Old Eureka.

The Wildman-Mahoney vein and the Lincoln vein are several hundred feet west.

Original Amador Mine, adjoining the Bunker Hill on the south, was first opened in 1852. The geology and mine workings were described by James D. Hague in 1872 and the next two paragraphs give a synopsis of his report.

The underground workings extended 650 feet northwest from the south boundary. There were three shafts, of which the south shaft was 175 feet deep, the middle one, 196 feet northwest from the first, was 356 feet deep, and the third shaft was just started. The vein, having hanging and footwall seams, varied from one to 20 feet wide, had a hard, slaty greenstone hanging wall and black slate footwall. The hanging wall vein was usually the larger, was of hard, white quartz, frequently mixed with greenstone and sometimes joined to the greenstone of the hanging wall with no gouge nor well defined limit between. The footwall vein was narrower, and in the black slate. It showed an abundance of clefts or crevices in which were seams of sulphurets and visible free gold. This vein was always the richer of the two, and was stoped in the old workings (above 356 feet in depth), while the hanging wall vein was left. The veins at times were together, at times separated. Below the third level the vein pitched east into the greenstone, with 50 feet of greenstone between the vein and the footwall slate.

A 40-stamp mill was completed in 1872, an English company having purchased the property. About 3600 tons of ore crushed yielded from \$4 to \$6.50 a ton, and the tailing loss was \$2.50 to \$3.26 a ton. This company spent considerably more than they took from the mine during the next two years, but no complete record of their work remains.

The later work by Original Amador Consolidated Mines Company began in 1898 and continued until early in 1917, since when the mine has lain idle. The shaft was sunk to a depth of 780 feet, on an incline of 72° to the 200-ft. level and 45° below there. The slate vein was prospected for 900 feet and the contact vein was also extensively prospected. In the greenstone east of the contact vein, three other veins were found, consisting of schist and quartz stringers. A large tonnage of low-grade ore was developed, estimated to average about \$3 a ton. Previous to 1915 a mill of twenty 1000-lb. stamps and eight Deister

concentrators, with a capacity of 90 tons of ore daily, was operated. The ore crushed during this period averaged about \$3.30 a ton and the total operating cost averaged \$2.56 a ton. However, it should be stated that during part of this time the ore came from development work. About two-thirds of the gold recovered was free. The concentrate averaged about \$80 a ton and the recovery was about 90%. The mill was remodeled in 1915. Two 8-ft. by 3-ft. Hardinge mills, classifiers, etc., were installed and the capacity was trebled. Closing was hastened by complaints of farmers regarding damage to their lands by tailing.

This mine and the Bunker Hill are now under the same ownership, and the Original Amador could be prospected at considerable depth through the Bunker Hill shaft. Both mines contain considerable low-grade ore.

Plymouth Consolidated Mine at Plymouth has undergone many changes since our last report in 1923. Under the Plymouth Consolidated Mining Company, the main shaft was sunk 900 feet from 3400 to 4300 feet. For some time previous to this ore had been mined through a winze, hoisted to the 3400-ft. level, then trammed to the shaft to be hoisted to the surface. Both shaft and winze were in poor shape and work was at a disadvantage. In February, 1925, the mine was forced into a receivership and closed February 28, because of inability to pay notes amounting to \$50,000 secured by a mortgage. In May, 1925, it was bought by Argonaut Mining Company, and was reopened at once. The shaft was sunk an additional 150 feet, making its total depth 4450 feet, of which the first 1600 feet is vertical and the balance on an incline of 60°.

The principal orebody has been stoped out between the winze and shaft as far down as the 4300 level, and is being stoped now from the 4450 to 4300 level. Ore occurred in it in the shape of comparatively small lenses. The operation of this mine had not paid a profit for a number of years under the former company, and the average grade of ore has remained low since the present operators began milling, and they have made no profit, although they have reduced costs by eliminating overhead expenses and improving operating methods. They are milling 3500 to 4000 tons of ore a month and have been running the mill since May, 1925, except for five months between April and September, 1926. The oreshoot in the levels worked in late years has had an average length of about 275 feet and an average width of 11 feet. This is north of the shaft. On the 3400 level, south of shaft, another small orebody about 100 feet long is being stoped and prospected.

The Empire oreshoot, on the north, and Pacific oreshoot on south merged at about the 2900-ft. level. The ore in the Empire oreshoot has always been bounded on the north by a meta-andesite dike entering from the footwall side. This outcrops 2850 feet north of the Pacific shaft, and where crosscuts have passed through it had a thickness of about 100 feet. The gouge and ore stop at this dike, which persists to the greatest depth yet reached. In the lower levels the andesite turns away from the shaft on a curved course, indicating that it may be lens-shaped and may disappear at greater depth, as is at times the case with these dikes in the mines on this lode. On the lowest level the northern end of the orebody is now 800 feet north of the main shaft.

If the thickness of the dike is only 100 feet where crosseut, it must be a branch from the large mass of altered andesite extending many miles north and south. There is a gouge about two feet thick along the contact of the andesite, marking a fault of unknown amount or direction.

The main fault in this mine has been classed as reverse and post-mineral, having the same strike as the vein. It is marked by prominent gouges. In the upper workings it followed the footwall, but crossed the vein to the hanging wall side a little below the 1600-ft. level.

The oreshoots were found at or near the intersections of various veins which occur as seams or series of seams and banded quartz, the ribbons or bands containing graphite, slate, pyrite and arsenopyrite. Two vein systems occur, one striking north and the other N. 20° W. Both systems dip east, the first about 65°, cutting the cleavage of Mariposa slate both in strike and dip, the second from 70° to vertical, conforming more with the cleavage of the slate. The nature of this publication does not permit a full discussion of the interesting geologic features of the mine.

The total production of the properties now comprising the Plymouth Consolidated has been in excess of \$13,000,000. The old companies between 1860 and 1891 produced \$7,123,000 and Bewick, Moreing & Company between 1914 and 1925 produced about \$6,000,000. The average value of all ore milled between 1860 and 1924 was \$6.75 a ton. The operating cost during the past few years has been from \$5 to \$5.75 a ton, slightly exceeding the yield of ore.

Smith-Vincent Mine. Owner, Lewis Smith, Oleta. Lessee with option to purchase, Oleta Gold Mining and Milling Company. Charles Crane, manager, Oleta. It is about one mile northeast of Oleta, near the Fairplay road.

There is a shaft 300 feet deep, with one level at 150 feet and drifts 80 feet and 150 feet long on a vein said to be 2½ feet to 7½ feet wide; but mine was closed and full of water, so these figures could not be checked. The shaft crossed the vein about the 150-ft. level, and cross-cuts will have to be run to reach it below there. There are other veins of good width on which little has been done. The country rock is amphibolite schist, forming a small lens surrounded by Calaveras schists.

The above company installed an 80-h.p. steam boiler and 65-h.p. hoist and an air compressor, after discarding a smaller outfit. Oil for fuel was hauled 18 miles from Martel. When visited in August, 1926, the property was being prepared for reopening after having been shut down six months.

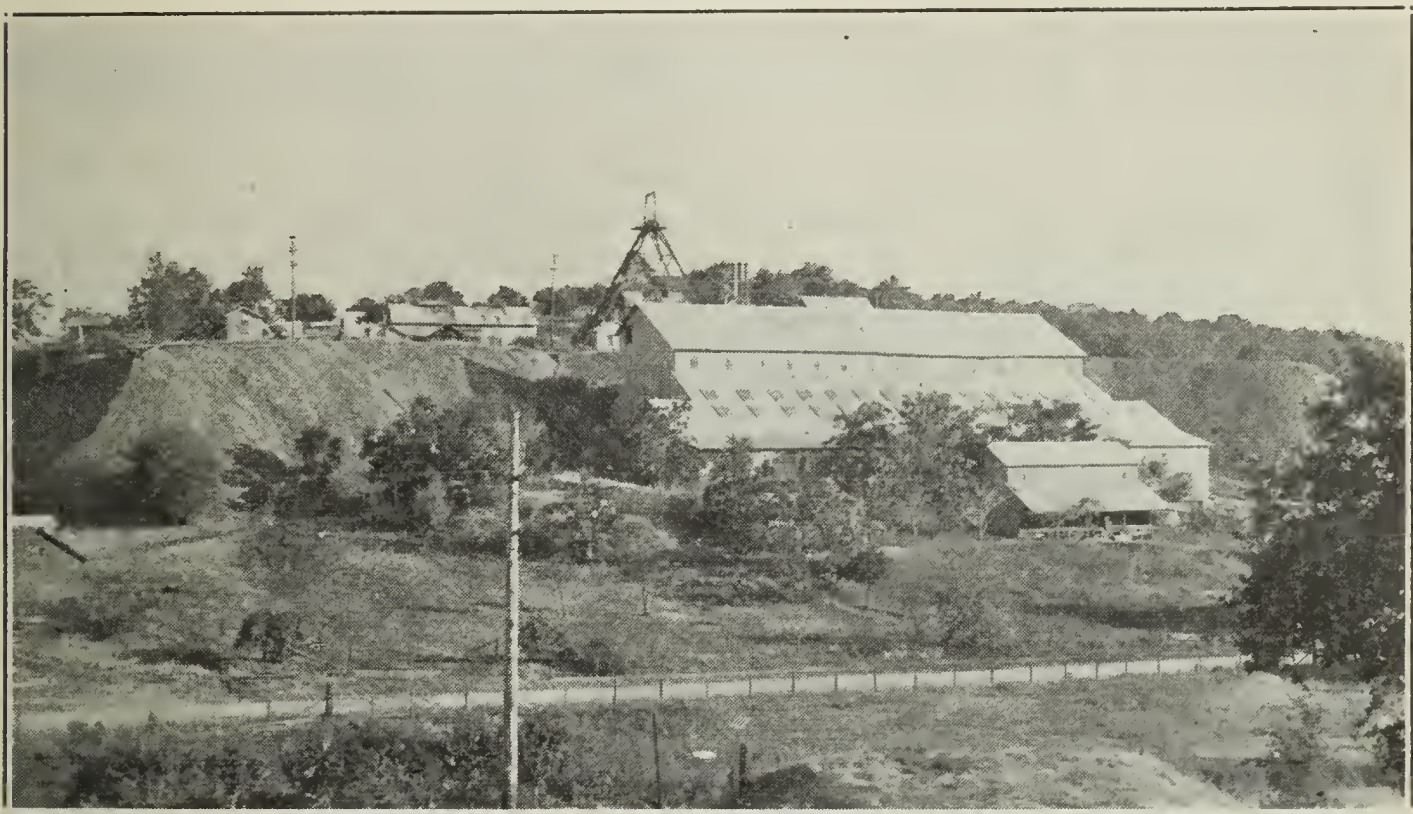
South Eureka Mine includes the Oneida Mine and the holdings cover practically all the mineral rights from the Kennedy on the south to the Central Eureka, including 401 acres.

The Oneida was one of the richest of the early-day producers. The ore on the hanging wall side was the best, yielding \$30 to \$40 a ton, according to J. Ross Browne.¹ The average yield in 1867 was \$22 a ton and in 1868 it was \$16 a ton.² In 1871 there were three shafts, 300, 700 and 800 feet deep, respectively. The vein was drifted for a

¹ Mineral Resources of the U. S., West of the Rocky Mtns., 1868.

² Raymond, R. W., Mineral Resources of U. S., West of the Rocky Mtns., 1869.

length of 800 feet on the 700-ft. level, and the oreshoots were said to have been 700 feet and 400 feet long. These old workings finally reached a depth of about 1000 feet, after which the property lay idle until 1896. In that year a new vertical shaft was started and it was expected this would strike the vein at a depth of 1750 feet, but on account of the vein assuming a steeper dip, it was not struck until the 1900-ft level. This shaft reached a depth of 2280 feet, and an inclined winze was sunk 250 feet at a point 280 feet north of the shaft. The mine was worked extensively from the 1200-ft. to the 2200-ft. level. On the 1200-ft. level, the vein was drifted 2700 feet, on the 1500-ft. level 2050 feet, and on the 2000-ft. level about 2300 feet. Ore was stoped from the latter level to the old workings. A 60-stamp mill was used. Operations continued until 1913, since when the mine has lain idle except for some work done through the South Eureka shaft. The production of the Oneida was about \$2,500,000. The main oreshoot



Mill and Surface Plant of South Eureka Mine, a former producer of the Mother Lode, near Sutter Creek.

had a length of 650 feet and an average width of 12 feet in the upper levels and five feet in the lower, but reached 20 feet in width in places.

The South Eureka lay undeveloped until 1891, due probably to the fact that most of the surface along the course of the Mother Lode fissure through the property is covered by andesite cobbles. In that year an inclined shaft was started which finally reached a depth of 2785 feet. To a depth of 900 feet the fissure was filled principally with crushed slate and gouge, containing only a little quartz. The ground was very heavy and the shaft expensive to keep open on account of having been sunk in this crushed slate. On the 900-ft. level, a crosscut revealed some ore on the east contact (hanging wall) of black slate and greenstone, but for the most part the ore was scattered in bunches in the gouge-filled fissure and did not make a good sized or profitable oreshoot. For ten years assessments were levied to continue prospecting. During this period a 20-stamp mill was in use part of the time. After 58 assessments had been levied and the 2750-ft. level had been reached,

a crosscut to the footwall encountered an important oreshoot. This was subsequently developed by crosscuts from the higher levels, and was stoped up to about the 2000-ft. level. The mill was increased to 80 stamps and the property for several years was one of the largest producers of the county, employing from 200 to 250 men. This oreshoot crossed the line into the Central Eureka property on the latter's 2700-ft. level, but went down only 30 feet there. The South Eureka Company sank a winze to 2900 feet inclined depth, drifted back and raised but failed to find more ore. They quit in 1918.

In 1921, the Central Eureka Mining Company took an option on the property and extended several of their deeper levels into the South Eureka. The 3350-ft. level south drift was run to a point 120 feet north of where the South Eureka shaft would be if continued. A west crosscut was run in greenstone near the north end-line of the South Eureka on this level. On the 3900-ft. level, the drift was extended about the same distance into the South Eureka, and a crosscut was run east in slate 740 feet. This cut several gouge seams and vein formations but no ore was found. The 4100-ft. level was also run into the South Eureka. The result of all this work was disappointing.

Since the South Eureka Mining Company quit, the shaft as far down as the 2740-ft. level, and the workings connecting the two mines on that level (Central Eureka's 2540-ft. level) and on the 1800-ft. level (Central Eureka's 1600-ft. level) have been kept in repair by the Central Eureka Mining Company. Water from the lower part of the Central Eureka Mine is pumped to their 2540-ft. level and piped thence to the South Eureka pump station which is maintained and operated by the Central Eureka Mining Company. The South Eureka shaft, over which the hoist is kept in running order, also serves as a second exit.

The 80-stamp mill had a capacity of 400 tons a day through 24-mesh screen, and a recovery of 85% to 91% was claimed, using amalgamation followed by concentration on 48 Frue vanners, according to the regular Mother Lode practice. The value of ore milled in 1914 and 1915 ranged from \$3.60 to \$4.34 a ton and in 1915, 145,124 tons were mined and milled, giving a recovery of about \$575,000. The operating cost ranged from \$2.80 to \$3.09 a ton in those years.

South Spring Hill Mine, adjoining the Keystone on the south, was worked to a depth of 1200 feet on the contact vein, on part of an ore-body worked also in the Keystone. The portion within the South Spring Hill is said to have been 600 to 750 feet long and the mine's production is reported to have been about \$2,000,000. The ore was higher grade than that last mined in the Keystone. This mine has been idle about 25 years. Its principal period of activity was about 1888-1890, it having been in operation at intervals since 1851.

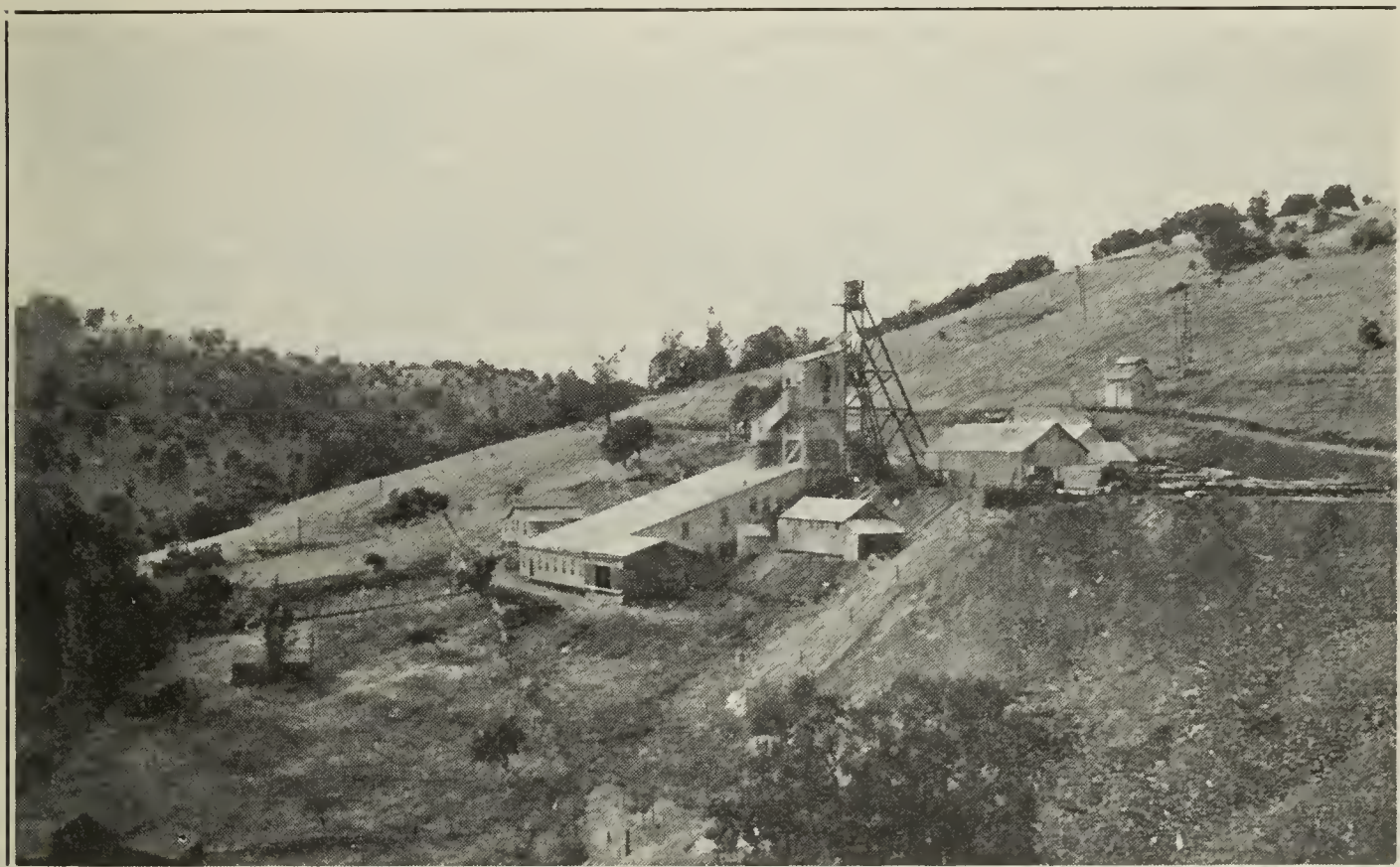
The property includes the Mcdean and Talisman claims, on both of which early-day discoveries were made, and on which shafts were sunk, each to a depth of about 600 feet. The Keystone Mining Company has recently purchased the South Spring Hill holdings.

Sunset Mine. Being operated by Sierra Metals Corporation. B. W. Bours, general manager, 701 Crocker Building, San Francisco. Ben Sanguinetti, superintendent. It is three miles southwest of Martel by road.

This property was first worked 50 years ago, but had lain idle a long time until reopened by Ratto in 1922. Some promising ore was found and the claim was taken over soon after by the company.

The deposit is a gash vein of quartz in the diabase. The vein strikes north to northwest and dips east. It has the form of lenses, one of which will pinch when followed along the strike, to be succeeded by another. The diabase is altered and oxidized to about the 400 level and the difference in appearance between this oxidized zone and the fresh rock below there led to the erroneous belief that the two were different rocks. The walls of the vein are hard, with little gouge. The white quartz contains a little arsenopyrite, pyrite and copper minerals as well as free gold.

The inclined shaft is 600 feet deep, with levels called the 300, 400 and 500. Crosscuts run east to the vein with drifting 400 feet north on the 300 level, 120 feet north on 400 level, and 160 feet north and 40 feet



Treasure Mine and Mill.

south on 500 level. The width of vein varies from three feet to a few inches, and the value is spotted. Some specimens show considerable free gold, but 1200 tons crushed were of medium to low grade.

The surface plant includes a mill of five stamps with a daily capacity of 20 tons, a Frue vanner, 2-drill air compressor, 35-h.p. electric motor, and hoist run by 22-h.p. motor.

Treasure (Hazard) Mine was first worked previous to 1867, at which time it had an 8-stamp mill. It had produced 5000 tons of ore, some of it worth \$15 a ton, up to that time. It was reopened in 1907 by Treasure Mining Company, and operated until September, 1922.

The Treasure Mine adjoins the Bunker Hill Mine on the north. It was worked to an inclined depth of 3030 feet, the first 1600 feet of which is a shaft on an incline of 58° to 60° and the balance a winze. Levels were run about 160 feet apart, the later workings having extended from 1800 to 2970 feet, and connection was made between

the 1600 level of the Treasure and 1500 level of Bunker Hill. The upper levels worked the usual Mother Lode veins, but about the 400-ft. level the vein passed from the slate into the meta-andesite or 'schist,' which furnished the ore mined in later years. This was a disseminated sulphide ore, formed by the alteration and impregnation of the 'schist,' which contains minerals susceptible to chemical solution, so that the original constituents of the rock have been largely changed and charged with 2% to 4% auriferous sulphides, principally pyrite. This orebody was reported 18 feet wide. It was cheaply mined, and a method of ore treatment different from that practiced elsewhere on the Mother Lode was followed. It is described because it differed from the standard practice so radically.

Ore from the skip was dumped over a one-inch grizzly. Oversize ore passed to a gyratory crusher, product from which passed to a trommel 10 feet long with largest screen openings $1\frac{1}{2}$ -inch. Minus $\frac{7}{16}$ -inch ore passed to fine ore bin and plus $\frac{7}{16}$ -inch, minus $1\frac{1}{2}$ -inch, to coarse ore bin. Oversize from the trommel passed to a 7-inch by 10-inch Dodge crusher, and then to coarse ore bin. Belt conveyors fed coarse ore to a large Hardinge mill and fine ore to a smaller one. The large mill ground to $\frac{1}{4}$ -inch and the pulp from it passed to a Bunker Hill revolving screen (slots equal to 16-mesh) where it was thinned. Fines through screen went to shaking plates and coarse sand retained went to a small Hardinge mill, from which fines passed to shaking and stationary plates and coarse was returned by sand pump to Bunker Hill screen, etc.

Pulp from the plates was pumped upstairs to classifiers, from which coarse pulp went to two Wilfley tables, the tailing from which was reground; fines (overflow) went to cone classifiers which discharged their underflow to two Overstrom concentrators and overflow to eight Frue vanners. Electric power operated a 35-h.p. motor for the large Hardinge mill and a 75-h.p., 440 volt, 93 ampere motor for driving the rest of the machinery. The rated capacity was 150 tons in 24 hours.

The best ore in the mine was above the 2320-ft. level, below which a fault cut off ore, although a large low-grade vein was reported below. This fault is important to all three adjacent mines. It strikes east and dips south, traversing the property. The Treasure Mine made a gross production of about \$1,000,000, but paid no dividends as the surplus was exhausted looking for more ore.

Velvet Mine. Owner, Charles Hagberg. Lessees, Ray and Victor Hageman. The lessees took out about 27 tons of ore in 1924 that yielded \$1100. This was said to have been taken from a shaft 60 feet deep. There is a small steam hoist and compressor here. The Pine tunnel, about 100 feet long, was run many years ago and is in very hard rock. This property is near the Defender Mine, in the granodiorite.

Zeila Mine (originally called the Coney) and the *Blue Jacket* adjoining, were known even in early days as mines whose ores carried their gold largely in the sulphides, differing in this respect from most of the others on the Mother Lode. The Zeila is at the south side of the town of Jackson, on the most easterly of the veins of the Mother Lode. The property was shut down in 1914 after operating over 30 years, and has lain idle since. Therefore no recent first-hand information has

been obtainable, and former published reports except one by Storms (see post) are meager and mostly valueless. The Zeila is one of the mines which could be worked at a profit under conditions which existed prior to 1914, but so far as can be learned the ore has been of uniformly low average grade. According to Folio 63 of the U. S. Geological Survey:

"The vein is essentially a stringer lead in amphibolite schist and has a general dip of 50° to 60° E. It is separated from the black slates (Calaveras formation) of the footwall by a heavy gouge. The width of the vein where stoped is 40 to 50 feet, but the general average is somewhat less. A fine-grained, altered dike, from 4 to 6 feet wide, probably originally a diorite, accompanies the vein. The ore is of low grade—less than \$4 per ton. Pyrite is the principal sulphide, but there is sometimes a little molybdenite, and small quantities of galena and zincblende are said to occur and to indicate good ore. Calcite is quite abundant, both as stringers and crystallized with the quartz."

The shaft was sunk 1700 feet on an incline of 65° . The 1570-ft. level drift was run north 3000 feet, and on that end a winze was sunk 458 feet, with levels at 157 and 295 feet, which were also drifted north, the latter 450 feet. At the time of closing it was stated the mine contained 360,000 tons of ore averaging less than \$4 a ton. It was stoped out from the 1200-ft. level to the surface, north of the shaft, where the oreshoot was 600 feet long and averaged 20 feet wide.

According to W. H. Storms¹ the average expense of mining and milling here was about \$3 a ton in 1900. The mill contained 40 stamps, weighing about 800 lbs. each and crushing four tons each daily through No. 16 brass wire screen; finer crushing was said to save a little more free gold, but resulted in greater loss by sliming the concentrate. The free gold was only 35% of that recovered. The sulphides formed $2\frac{1}{2}\%$ of the ore and contained \$100 gold per ton.

The total production must have been over \$5,000,000.

Other Small Mines and Prospects.

In the Pine Grove and Pioneer districts there are numerous small mines which show activity during the dry season. In general, these show the same characteristics as those in the larger West Point district, south of Mokelumne River in Calaveras County, of which these districts are geologically a part. The veins usually are narrow, the ore is high grade but as a rule pockety. Below the oxidized zone, in which many pockets have been found, sulphide ore which is often complex comes in. Among these properties may be mentioned the following:

Amador Columbus and *West Columbus*. Equipped.

Columbus No. 3 and a number of others belonging to the same owners were being prospected in 1926.

Crammer Mine. Lately under option.

Dane-Mitchell Mine. Recently active. A former producer.

Haverly Bros. Mine. Lately under option to A. G. Fraser, Los Angeles.

Spagnoli Mine. Formerly a producer of pockets, one of \$16,000 having been found. Three men are prospecting.

¹ Cal. State Mining Bureau, Bulletin 18, pp. 45-49.

TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
A. and B.-----	14, 13 11	7 N. 7 N.	10 E. 10 E.	} Mrs. Maggie Reaves, 1316 Eighteenth St., Sac- ramento; John C. Reaves, Plymouth, agent.---	1,050	13	XIV, p. 14.
Acme-----					2,750	---	XIII, p. 66; XIV, p. 14.
Acme Cons. et al.-----	9	5 N.	11 E.	Acme Mining Co.-----	---	72	See Amador Gold.
Aetna-----				Mat. and Edw. Muldoon, Jackson-----	---	---	See Middle Bar.
Albany-----				---	---	---	See Tripp.
Allison-----	33	8 N.	10 E.	State of California-----	1,000	20	XIII, p. 66; XIV, p. 14.
Alma-----	28	6 N.	11 E.	Alma Mining Co., F. C. Siege Estate, H. Paulson, Secy., 432 Battery St., San Francisco; John B. Frances, Jackson, agent-----	1,500	150	XII, p. 70; XIII, pp. 66-67; XIV, pp. 14-15.
Alpha-----				---	---	---	See West Eureka.
Alphi-----	34, 35	6 N.	11 E.	W. H. Taylor, Jackson-----	---	19	XIII, p. 67; XIV, p. 15.
Alpine-----	2	7 N.	10 E.	Alpine Mining Co., Box 43, Menlo Park-----	1,100	12	XX, p. 75.
Amador Columbus-----				F. L. Hensen, 251 Kearny St., San Francisco-----	---	---	See Old Eureka.
Amador Cons.-----				---	---	---	
Amador Gold and Amador Queen Nos. 1 and 2, Aetna, School- house et al.-----	34	6 N.	11 E.	W. J. McGee, Jackson-----	1,000	167	IX, pp. 88-93; X, pp. 102-103; XII, p. 71; XIII, p. 72; XIV, p. 15; Bull. 18, p. 44.
Amador King-----	23	8 N.	10 E.	A. Brown, H. A. Meyers, T. Levaggi, Plymouth-----	900	407	XIV, p. 15; Bull. 18, p. 86
Amador Queen No. 2-----	34, 35	6 N.	11 E.	Amador Improvement Co., Mission and Twenty- second St., San Francisco-----	1,000	60	VIII, pp. 91-93; X, p. 107; XII, p. 71; XIV, p. 16; Bull. 18, p. 44.
Amador Star-----	23	8 N.	10 E.	Henry Kaiser, 1443 S. San Joaquin St., Stockton-----	---	130	
Ama Oro-----	22	7 N.	12 E.	Ama Oro Mining Co., 204 Westbank Bldg., San Francisco-----	2,440	90	XIV, pp. 15-16. See New York.
Anderson-----				---	---	---	
Anita-----	28	6 N.	11 E.	Anita Mining Co., 407 Montgomery St., San Francisco-----	---	44	XIII, p. 68; XIV, p. 16.
Argonaut-----	17, 20 21	6 N. 6 N.	11 E. 11 E.	Argonaut Mining Co., 404 Humboldt Bank Bldg., San Francisco-----	1,550	78	XIII, p. 68; XIV, pp. 17-19; XVII, pp. 406-408; XVIII, p. 298; XIX, pp. 13-14; XX, pp. 2, 177; Pre. Rep. 8, pp. 23-24; Bull. 18, pp. 50-52.

Astoria-----	13, 14	7 N.	10 E.	Mrs. Anna Bona, Sutter Creek (See Jose Gulch.)	-----	15	See Middle Bar Group.
Atlantic-----	-----	-----	-----	-----	-----	-----	-----
Aurora-----	-----	-----	-----	-----	-----	-----	See White.
Australian-----	-----	-----	-----	-----	-----	-----	Bull. 18, p. 86.
Azula-----	22	7 N.	12 E.	F. Devencenzi and F. Garibaldi, Volcano	-----	-----	-----
Babcock-----	-----	-----	-----	-----	-----	-----	See Old Eureka.
Badger-----	5	6 N.	11 E.	-----	1,200	-----	Bull. 18, pp. 75-76.
Baliol-----	23	8 N.	10 E.	Mrs. John Ballard, 1917 Baker St., San Francisco	1,000	160	-----
Ballard-----	23	8 N.	10 E.	Stockton Savings Bank, Stockton, Levaggi Est. Co., Plymouth, agents	1,000	80	XI, p. 146; XII, p. 71; XIII, p. 69; XIV, pp. 19-20; Bull. 18, pp. 85-86.
Bay State-----	-----	-----	-----	-----	-----	-----	See Contention.
Belding-----	21	6 N.	11 E.	(Now part of Kennedy Mine)	1,180	-----	X, pp. 104-105; XI, p. 141, XII, p. 71; XIII, p. 69.
Bellwether-----	32	7 N.	13 E.	Frank Seulberger, John McKelvey, Oakland Sav- ings Bank Bldg., 418 Fourteenth St., Oakland	2,400	15	XIV, p. 20.
Belmont-----	32	7 N.	13 E.	J. J. Hall, J. B. Grillo, Volcano	-----	-----	VIII, pp. 73-75; IX, p. 143; XI, p. 143; XII, p. 71; XIII, p. 69; XIV, pp. 48-49; Bull. 18, p. 76.
Brenardis-----	-----	-----	-----	-----	-----	-----	XIII, p. 69.
Black Hill-----	-----	-----	-----	-----	-----	-----	See Loyal Lode.
Blue Lakes-----	24	7 N.	10 E.	Charles Boro, Drytown	-----	-----	VIII, p. 97.
Boro-----	25	7 N.	10 E.	Dr. Thos. Boydson's Estate, Plymouth, 1/2; Fre- mont Mining Co., 1/2	-----	20	-----
Bona Fortuna-----	28	6 N.	11 E.	Anita G. Mining Co., Jackson	-----	45	-----
Bright-----	14	7 N.	10 E.	See Jose Gulch.	-----	-----	-----
Brown-----	-----	-----	-----	Estate of P. B. Cornwall, 128 Sutter St., San Francisco, c/o Colwell, Cornwall and Banker	-----	17	-----
Bruce-----	25, 36	7 N.	10 E.	J. W. Bullock, Seattle, Wash.	-----	76	VIII, pp. 57-63; X, p. 75; XI, p. 79; XII, p. 79; XIII, p. 77; XIV, pp. 20-21; XVII, pp. 408-409; XVIII, pp. 298-299; XIX, pp. 2, 15; XX, p. 2; Pre. Rep. 8, p. 24.
Bunker Hill, Mayflower and Ne- vada-----	4	6 N.	11 E.	Dr. Espy L. Smith, c/o Illinois Merch. Trust Co., 3122 Washington blvd., Chicago, Ill.	-----	150	-----
Burlington-----	1	7 N.	12 E.	Parquet Mining Co., Tracy	2,850	60	Bull. 18, p. 45.
Butte-----	23, 24	7 N.	10 E.	W. F. Detert, 995 Market st., San Francisco	-----	-----	XIV, p. 23.
Caledonia-----	-----	-----	-----	-----	-----	-----	-----
California et al.-----	-----	-----	-----	-----	-----	-----	-----

*Ownership given in this table is that shown in the county tax records.

TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY—Continued.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Casco							
Caucasian Cons.	23	8 N.	10 E.	Wm. J. McGee, Sutter Creek			See Hardenberg. X, p. 120.
Centennial							Bull. 18, p. 82.
Central Eureka (including Old Eureka)	7, 8	6 N.	11 E.	Central Eureka Mining Co., 519 California St., San Francisco		182	VIII, p. 49; X, p. 104; XI, p. 144; XII, p. 79; XIII, pp. 69-70; XIV, p. 24; XVII, pp. 409-410; XVIII, p. 299; XIX, p. 2, 15; XX, p. 2; Bull. 18, pp. 64-65; Pre. Rep. 8, p. 24.
Chief et al.	14	7 N.	10 E.	Estate of Dr. Thos. Boydson, Plymouth			
Chili Jim	24	7 N.	10 E.	W. F. Detert, 3/5; P. B. Cornwall Estate, 2/5			
Clinton Cons.	9	6 N.	12 E.	Charles Wieland, San Francisco	2,700	320	XI, pp. 142-143; XII, p. 72; XIII, p. 78; XIV, p. 26.
Clough							See Reward.
Clyde	17, 20	6 N.	11 E.				X, pp. 110-111.
Colorado							See Kate Gray.
Columbus No. 3				S. A. Eastburn & DuBoise, Volcano			
Comet	6	6 N.	11 E.	Mary Baumhardt and Helen Agen, c/o Mrs. H. Agen, R.F.D. C-152-A, Modesto			
Contention				Thomas Severus, West Point			
Cons. McNamara	3	5 N.	11 E.	Mother Lode Mining Co., c/o L. Newman, 272 O'Farrell St., San Francisco	1,200	7	X, p. 114; XIV, p. 26. XIII, p. 70; XIV, p. 26.
Cooper	26	8 N.	11 E.	Mrs. Gehn, Des Moines, Iowa			
Cosmopolitan, Dry Creek, Henry Clay	14	7 N.	10 E.	C. T. Crocker, c/o K. F. Crocker, 55 Garnet St., Fitchburg, Mass.	900	100	Field Report.
Crannis	10	5 N.	11 E.	Chas. A. McKinney, Jackson		9	
Creek Ledge	35	8 N.	10 E.	Webb Smith, Jackson, et al.	1,000	160	XIV, p. 27.
Croesus and St. Martin	26	8 N.	10 E.	Estate of Martin Snable, c/o Levaggi Estate Co., Plymouth		39	
Crown							See Jose Gulch.
Crown Point				Crown Point Mining Co., Oakland			XII, p. 92; XIII, p. 70; XIV, p. 27.
Crown Point	22, 23	7 N.	10 E.	Mary E. Fontenrose, Jackson			

Dane & Mitchell Defender	33 29, 32	7 N. 7 N.	12 E. 13 E.	Dane-Mitchell Mining Co. West Point Cons. Mines, Inc., c/o V. M. Airola, Madera	2,400	23	XIII, p. 70; XIV, p. 27. XIV, p. 27; XX, p. 75; Pre. Rep. 8, p. 24.
Douglas	28	7 N.	12 E.	Mrs. S. E. McLaine, 2222 Washington St., San Francisco			
Dowling	27, 28	6 N.	11 E.	South Jackson Mining Co., Jackson		8	VI, pp. 20-21; XII, p. 72; XIII, p.
Downs	13	7 N.	12 E.	C. R. Downs, Sutter Creek	2,400	17	70; XIV, p. 27.
Doyle	34	6 N.	11 E.	Mrs. Catherine Doyle, Jackson	975	18	X, p. 107; XII, p. 72; XIII, p. 70; XIV, p. 27.
Drytown Cons.	22, 23	7 N.	10 E.				X, p. 116.
East Eureka	7, 8	6 N.	11 E.	L. A. Poundstone, Grimes	1,500	45	X, p. 72; XII, p. 71; XIII, p. 67; XIV, p. 28; Bull. 18, p. 63.
East Keystone							See Keystone.
Easton							See Shenandoah.
Ebelbrau	23	8 N.	11 E.	Frank Treganza, 3981 Third Ave., Sacramento (Now Original Amador)		20	X, p. 114.
Eclipse	36	7 N.	10 E.				X, p. 99; XIV, p. 27.
El Dorado	36 31	7 N. 7 N.	10 E. 11 E.	T. C. Mayon, 1531 Market St., Oakland, et al.	900	13	See Middle Bar Group.
Elephantine							
Elkhorn	28	7 N.	13 E.	John and James Grillo, Volcano		19	
Enoch	33, 34	7 N.	12 E.	E. A. Trask, Pine Grove	2,400	25	XIV, p. 28.
Eureka	7, 8	6 N.	11 E.	Central Eureka Mining Co., 519 California St., San Francisco	1,200		X, p. 72; XIII, p. 67; XIV, p. 28; see Old Eureka.
Evans							XII, p. 78; XIII, p. 70.
Excelsior	23	8 N.	10 E.	Gertrude V. Clark, Sutter Creek		20	
Excelsior	25 30	7 N. 7 N.	10 E. 11 E.	J. W. Bullock, Seattle, Wash.	1,350	22	XIV, p. 28.
Extension	11	7 N.	10 E.	L. L. Rich, 136 Liberty St., New York, et al.		17	
Farrell	15	5 N.	11 E.	Estate of Rose Rosenberg, c/o Joe Rosenberg, 215 Bacon Bldg., Oakland	600	9	X, pp. 107-108; XII, p. 72; XIII, p. 70; XIV, p. 288.
Florence	4	6 N.	12 E.	Edm. B. Dennison, c/o Mrs. F. Dennison, 1547 Clay St., San Francisco		12	
Fort John	11	7 N.	10 E.	E. Rose, c/o E. S. McCurdy, 575 Mills Bldg., San Francisco			
Focus	33	7 N.	12 E.	Knight and Co., Sutter Creek	2,600	25	XIII, p. 70; XIV, p. 28.
Forty-Nine	14	7 N.	10 E.	E. S. Barney, Hayward		19	X, p. 122.
Free American							Bull. 18, pp. 76-77.

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TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY—Continued.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Fremont	25	7 N.	10 E.	Fremont Cons. Mining Co., 24 Market St., San Francisco	1,000	150	VIII, p. 53; X, p. 75; XI, p. 146; XII, p. 72; XIII, p. 71; XIV, pp. 28-29; XVII, p. 411; XVIII, p. 299; XIX, pp. 15, 73, 143; XX, p. 2; Pre. Rep. 8, p. 24; Bull. 18, pp. 80-81.
Gillett	34	8 N.	11 E.	c/o Herman Wedler, 2330 Myrtle St., Oakland	1,800	10	
Golden Crown	18	7 N.	11 E.	C. R. Downis, Sutter Creek		23	X, pp. 113-114.
Golden Eagle, Triumph	6	6 N.	11 E.	John F. Davis, Humboldt Bank Bldg., San Francisco			
Golden Gate	14	7 N.	10 E.	Chas. Kretcher, R.F.D. 1, box 36, Placerville, 1/2; W. F. Detert, 995 Market St., San Francisco, 1/2		20	
Golden Gate	14	8 N.	10 E.	Mrs. L. Cassinelli, Volcano		17	
Golden Gate	12, 13	7 N.	12 E.	Gold Mountain Mining Co., 1231 Jones St., San Francisco		12	
Gold Mountain	19	7 N.	11 E.		1,300	20	VIII, p. 94; XI, p. 145; XII, p. 72; XIII, p. 71.
Good Hope	28	6 N.	11 E.	C. P. Vicini, Jackson, et al.; Good Hope Mining Co., c/o J. F. Davis, Humboldt Bank Bldg., San Francisco	1,100	40	XIII, p. 71; XIV, p. 29. VIII, pp. 53-57; X, p. 75; XI, p. 146; XII, pp. 72-74; XIII, p. 71. Bull. 18, p. 85. XIII, p. 71.
Gover	25	7 N.	10 E.				XIV, p. 29.
Gowanus				George Andrews, P.O. Box 246, New Liskeard, Ontario	2,500	19	
Gracey Mill	32	8 N.	13 E.	Great Eastern Mining Co., c/o Elmer Tripp, Plymouth		14	
Grand Prize	23	8 N.	10 E.	O. Ball, Plymouth		8	
Great Eastern	2	7 N.	10 E.				See Belmont. XVIII, p. 7. X, pp. 68, 106-107; XI, pp. 139-140; XII, p. 74; XIII, p. 71; XIV, pp. 29-30.
Grey Eagle							
Guliana							
Hagerman							
Hardenburg	10 3	5 N. 6 N.	11 E. 11 E.	Wm. J. and Ralph McGee, Sutter Creek	825	45	

TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY—Continued.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Kirkwood							Bull. 18, p. 45.
Kruger and Vaughn (Lots 55 and 59)	3	5 N.	11 E.	F. and J. Champion, 468 Rich St., Oakland		40	
Lady Bedford	14	8 N.	10 E.	E. Steel, ½, c/o G. M. Steel, Lodi; ½ to Williams, Strange and Smith, 309 S. School St., Lodi			X, p. 107.
Last Chance	36	7 N.	10 E.	J. W. Bullock, Seattle, Wash. (Consolidated with Original Amador)	1,200		
Levaggi	27	7 N.	13 E.	Levaggi Estate Co.; J. Esola, West Point, agent	2,150	80	X, p. 115.
Lincoln Cons.	6, 7, 8,	6 N.	11 E.	Lincoln Cons. Mining Co., Sutter Creek	1,200	380	XIV, p. 36. VIII, p. 73, 75-79; IX, pp. 73, 75-78; X, pp. 100, 101-102; XI, p. 144; XII, pp. 79-80; XIII, pp. 73-74; 78-79; XIV, pp. 36-37. XIII, pp. 72-73. New Albany Cons. XIV, p. 37.
Little Amador	36	7 N.	10 E.				
Littlefield							
Little Illinois	23	7 N.	10 E.	J. H. Thomas Estate, Drytown	800	36	
Little Sargent	10	5 N.	11 E.	Estate of A. Caminetti, Jackson			
Live Oak	14	7 N.	12 E.		2,300		
Lone Willow Group	21	7 N.	13 E.	Charles Gracey, Pioneer	2,800	60	VIII, pp. 79-80. XIV, p. 37.
Loyal (or Loyal Lode)				(Now part of Fremont Mine)			VIII, pp. 51-53; XIII, p. 73.
Lucille				Plymouth Cons. Gold Mines			VIII, pp. 49-51; X, pp. 117-118; XII, p. 78; XIV, p. 37; XIII, p. 73.
Lucky Strike et al.	Pioneer Sta.			Mrs. Louise Cassinelli, Voleano, c/o L. L. Patrick			XII, p. 78; XIII, p. 73; XIV, pp. 37-38.
Madrona Group	20, 21	7 N.	13 E.	L. Cassinelli, Voleano	2,900	140	VIII, p. 73; X, p. 72; XII, p. 78; Bull. 18, pp. 65-71.
Mahoney				(Part of Lincoln Consolidated)			
Mammoth	10	5 N.	11 E.	F. W. Patterson Estate, Fresno; Alex. Chalmers, Angels, agent; Federal Dev. Co., c/o S. L. Jones, 176 Townsend St., San Francisco	650	26	VI, pt. 2, pp. 21-22; VIII, pp. 93-94; X, p. 119; XI, p. 67; XII, p. 78; XIII, p. 74; XIV, p. 38; XIX, p. 143.
Mammoth	3	6 N.	12 E.	Mammoth Mining Co., c/o J. H. Kirby, Elk Grove		20	

Marklee-----	1	7 N.	12 E.	Marklee Mining Co., c/o W. H. Bley, 712 Ohio St., Vallejo-----	3,020	80	XIII, p. 74; XIV, p. 38; XX, pp. 3, 73-74.
Maryland-----	24	7 N.	10 E.	Estate of P. B. Cornwall, 128 Sutter St., San Francisco-----	-----	13	See Jackson Gate.
Massa-----	-----	-----	-----	-----	-----	-----	-----
May Ella-----	11	7 N.	10 E.	C. H. Shields and S. Wilds, Plymouth-----	-----	18	XII, p. 78; XIII, p. 74.
Mayflower-----	-----	-----	-----	-----	-----	-----	X, p. 115; XIII, p. 74; XIV, p. 38.
McIntyre-----	6	6 N.	11 E.	John A. McIntire, 1530 O St., Sacramento-----	1,100	24	X, p. 106.
McKinney and Crannis-----	10, 15	5 N.	11 E.	-----	-----	-----	-----
Mechanics-----	4, 5	6 N.	11 E.	Wm. J. McGee and Trustees, Sutter Creek-----	-----	14	X, p. 112; XIII, p. 74; XIV, p. 38; Bull. 18, p. 76.
-----	32, 33	7 N.	11 E.	-----	-----	-----	-----
Medean-----	-----	-----	-----	Keystone Mining Co.-----	-----	-----	See South Spring Hill.
Meehan Cons.-----	10	5 N.	11 E.	W. Gibbert, J. Strohm, M. C. Fontenrose, Jackson-----	-----	24	-----
Meek-----	-----	-----	-----	-----	-----	-----	See Evans.
Middle Bar-----	-----	-----	-----	-----	-----	-----	See New Albany Cons.
Middle Bar Q. M.-----	10	5 N.	11 E.	Mrs. J. and G. Tureinovich et al., Jackson-----	-----	-----	-----
Middle Bar Group-----	3, 10	5 N.	11 E.	Mrs. Lena Glavinich and M. Thomas-----	700	80	X, pp. 108-109; XIV, p. 38
-----	15	5 N.	11 E.	-----	-----	-----	-----
Midway and Esmeralda-----	21, 22	7 N.	13 E.	W. Q. Mason, Pioneer-----	2,800	40	XIV, p. 38.
Mineral Point-----	3	5 N.	11 E.	H. E. Furman, Sutter Creek, et al.-----	-----	9	XIII, p. 74; XIV, p. 38.
Modoc-----	-----	-----	-----	Mace Co., Ione-----	-----	-----	-----
Monterichard-----	30	6 N.	11 E.	Pacific Gas and Electric Co., San Francisco-----	-----	20	-----
Monte de Oro-----	26, 35	8 N.	10 E.	c/o Levaggi Estate Co., Plymouth-----	-----	-----	-----
Monitor-----	14	7 N.	10 E.	Charles H. Shields, Plymouth-----	1,000	147	XIV, p. 38.
Moore-----	34, 33	6 N.	11 E.	Moore Mining Co., San Francisco; Central Land Co., c/o Alex Chalmers, Agent, cor. Park Way and Monte Ave., Piedmont-----	-----	7	-----
-----	-----	-----	-----	-----	1,125	200	VI, pt. 2, p. 20; VIII, pp. 84-85; XII, p. 78; XIII, p. 74; XIV, p. 38; XVIII, pp. 299-300; XIX, pp. 15-16; XX, pp. 3, 74, 177; Pre. Rep. 8, p. 24.
Moar Brothers-----	-----	-----	-----	-----	-----	-----	See Lucky Strike.
Morley-----	-----	-----	-----	-----	-----	-----	See Middle Bar Group.
Mountain King-----	4	6 N.	12 E.	W. B. Pitts and Mrs. Louise Pitts, Pine Grove-----	2,600	-----	XIV, pp. 38-39 (See Pitts).
Murray, Vaughn, Kruger-----	-----	-----	-----	See Kruger-----	-----	-----	X, p. 107.
Mutual-----	6	6 N.	11 E.	-----	1,300	-----	Bull. 18, pp. 74-75.
Nevill-----	-----	-----	-----	-----	-----	-----	See Mammoth Mine.
New Albany-----	10, 15	5 N.	11 E.	New Albany Cons. Gold Mining Co., Martin Jones, San Francisco, agent-----	600	100	XII, p. 78; XIII, pp. 74-75; XIV, p. 39.

*Ownership given in this table is that shown in the county tax records.

TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY—Continued.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
New Hope----- New London----- Newman----- New York-----	3	7 N.	10 E.	Mrs. E. Adams, Plymouth	-----	8	X, p. 121. See Lucille.
	6	5 N.	11 E.	L. Brewster, V. Fyke, W. C. Lucas, Plymouth. G. W. Anderson Estate, Stockton	-----	-----	X, p. 123; XI, pp. 140-141; XII, p. 78; XIV, p. 39; XIII, p. 75; Bull. 18, pp. 44-45.
North Gover----- North Star-----	25 6	7 N. 6 N.	10 E. 11 E.	(Part of Fremont Mine) South Keystone Mining Co., c/o Wm. Fergis, Tacoma	-----	-----	X, pp. 116-117; XIII, p. 75.
	6	6 N.	11 E.		1,300	8	VIII, pp. 71-72; X, p. 99; XII, p. 78; XIII, p. 75; XIV, p. 39. Bull. 18, p. 86. X, p. 115.
Nugget----- Occidental----- No. 1 and No. 2----- Old Eureka, Tanner Tunnel, Al- pha Mining Co.-----	6 5, 8 8	6 N. 6 N. 6 N.	11 E. 11 E. 11 E.	----- L. R. Poundstone, Grimes. Central Eureka Mining Co.	----- ----- 1,200	----- 38 111	X, pp. 72, 102; 113; XI, p. 144; XIII, p. 67; XIV, p. 28; XVII, p. 411; XIX, p. 73; XX, pp. 3, 74; Pre. Rep. 8, p. 24.
Old Oaker-----	4	7 N.	10 E.	Southerland and Southerland, c/o H. Hurd, 1st Nat'l Bank Bldg., Roswell, New Mexico	-----	17	See Smith-Vincent.
Oleta Gold Mining and Milling Co.----- Oneida-----	17	6 N.	11 E.	South Eureka Mining and Milling Co., 708 Alaska Commercial Bldg., San Francisco	1,300	283	VIII, p. 79; X, pp. 109-110; XII, p. 78; XIII, p. 75; XIV, p. 39; Bull. 18, pp. 60-63.
Oro Grande et al.----- Original Amador-----	29, 32, 33 36	7 N. 7 N.	13 E. 10 E.	Oscar Lofstad, 231 Pine St., San Francisco J. W. Bullock, Seattle, Wash.	----- 1,050	33	VIII, p. 42; X, p. 114; XII, p. 78; XIV, pp. 39-40; XX, p. 3.
Osceola-----	14	8 N.	10 E.	Osceola Mining Co., c/o Furi and Co., 521 Clay St., San Francisco	-----	120	See Plymouth Cons.
Pacific----- Parker----- Peerless----- Peerless, Coulter, Homestake	14 24	7 N. 7 N.	12 E. 10 E.	F. Eagon, 1026 Pierce St., San Francisco Seaton Mining Co., c/o H. A. Myers, Plymouth	----- ----- -----	21 9	Bull. 18, p. 45. See Seaton.

Penavita et al.	11, 12	7 N.	13 E.	Arthur Berg, Volcano.	3,000	20	XIV, p. 41. XIX, p. 300.
Penolay Ranch	25	8 N.	9 W.	E. R. Walker, 1628 Gower St., Los Angeles.		17	
Pension	14	8 N.	10 E.	J. J. Crawford, Humboldt Bank Bldg., San Francisco, et al.	1,000	140	XII, p. 78; XIII, p. 75; XIV, p. 41; Bull. 18, p. 84. XX, p. 75.
Piney Creek	14	7 N.	10 E.	Estate of Dr. Thomas Boydson, Plymouth.	1,100	20	VIII, p. 42; X, p. 112; XII, pp. 78-79; XIII, p. 75; XIV, p. 41; Bull. 18, pp. 83-84.
Pioneer				Moar Bros., Lessees, Pioneer Station.			See Argonaut.
Pioneer				W. B. Pitts and Mrs. Louise Pitts, Pine Grove.		139	XIV, p. 38; XX, pp. 74-75.
Pitts	4	6 N.	12 E.	Argonaut Mining Co., Humboldt Bank Bldg., San Francisco.	1,100	156	VI, pt. 2, pp. 15-16; VIII, pp. 42-49; X, p. 117; XI, p. 79; XII, p. 79; XIII, p. 75; XIV, pp. 37, 41-43; XVII, p. 411; XVIII, p. 301; XIX, pp. 16, 73; XX, pp. 3, 177; Pre. Rep. 8, p. 24; Bull. 18, pp. 82-83. XIV, p. 43.
Plymouth-Eureka	3	7 N.	10 E.	c/o J. Ninis, Plymouth.	1,050	40	
Plymouth Rock	10	7 N.	10 E.	Isaac W. Winans, Plymouth.		20	
Pocahontas	23, 24	4 N.	10 E.	W. F. Detert, San Francisco, and Alleny McWayne, Drytown.	900	46	X, pp. 122-123; XIV, p. 44; Bull. 18, p. 83. See Mechanics.
Potazuba				J. H. Durst and C. C. Castle, also assessed to W. L. Phillips, West Point.		20	X, pp. 120-121. Bull. 18, p. 87.
Price	26	8 N.	10 E.	Glanch Bros., Oleta, et al., and A. Perovich, Jackson.			X, pp. 119-120; XIII, pp. 75-76; XIV, p. 45; Bull. 18, p. 85.
Queen	33	8 N.	10 E.	Estate of Wm. Moon, Jackson.			X, p. 121. XIV, p. 45.
Red Crown	34	6 N.	11 E.	Oscar Lofstead, Defender.	2,200	50	XIII, p. 76; XIV, p. 45.
Red Oak	11	7 N.	10 E.	Hilda Clough, Pine Grove.	2,250	43	See Amador King. See Philadelphia. See Acme.
Red Tape	23	7 N.	13 E.				XIII, p. 76.
Reward	34	7 N.	12 E.	Mrs. Julia Sargent, Jackson.		193	X, p. 107; XIV, p. 45.
Rhetta				Seaton Mining Co., c/o H. A. Myers, Plymouth.	1,000	20	VIII, p. 42; XIII, p. 78; XIV, p. 45. X, pp. 121-122.
Richmond							
Robinson							
Robinson	2	7 N.	12 E.		2,500		
Sargent and Marlette	10	5 N.	11 E.		650		
Seaton	24	7 N.	10 E.				
Shakespeare	11	7 N.	10 E.				

*Ownership given in this table is that shown in the county tax records.

TABLE OF QUARTZ MINES AND PROSPECTS, AMADOR COUNTY—Continued.

Name of mine	Location			*Owner's name, address	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Shenandoah	35	8 N.	10 E.	Mrs. Hilda Brown, New York City	1,190	80	XIII, p. 70; XIV, p. 45; Bull. 18, p. 84.
Smith-Vincent	34	8 N.	11 E.	Lewis Smith, Oleta, owner; Oleta Gold Mining and Milling Co., operating company in 1926	2,000		XX, p. 3.
Somerset et al.				Defender Development Co., c/o J. B. Joyce, Volcano			VIII, p. 49.
South Cosmopolitan Group	24	7 N.	10 E.	South Eureka Mining and Milling Co., 354 Pine St., San Francisco	925		X, p. 113; XI, p. 144; XII, p. 79; XIII, pp. 76-77; XIV, pp. 45-47; Bull. 18, pp. 63-64.
South Eureka	17, 8	6 N.	11 E.		1,700	431	XIV, pp. 47-48.
South Jackson	28, 34	6 N.	11 E.	South Jackson Mining Co., Jackson; J. Schweitzer, Secy., 3600 Clay St., San Francisco	1,400	70	X, p. 115 Bull. 18, p. 77. See Bunker Hill.
South Keystone	6	6 N.	11 E.	Mrs. B. C. Clark, Sutter Creek, 3/4; J. A. McIntire, Sacramento, 1/4			VI, p. 18; VIII, p. 71; 80-84; X, pp. 73, 98, 99; XI, p. 145; XII, p. 79; XIII, pp. 74, 77; XIV, p. 48; Bull. 18, p. 77.
South Mayflower				Keystone Mining Co., c/o C. L. Culbert, Secretary, Jackson	1,100	38	Bull. 18, p. 45.
South Spring Hill (including Meadean and Talisman)	31	7 N.	11 E.				VI, p. 19; XII, p. 79.
Spagnoli	9	6 N.	12 E.	Ernest Krentz, Valley Spring			XIII, p. 77; XIV, p. 48.
Stewart				(Now part of Lincoln Cons.)			XIII, p. 77; XIV, p. 48.
Stickel	9	6 N.	12 E.	Mrs. S. W. Steele, 30 E. San Fernando St., San Jose		20	XIII, p. 77.
St. George				Thomas George, Plymouth, et al.			See Central Eureka.
St. Julian	10	5 N.	11 E.	Bank of Amador County, Jackson	900	12	XX, p. 75.
Strong				Central Eureka Mining Co.			See Belmont.
Summit				John Ratto, Sutter Creek; Sierra Metals Corporation, operating, 701 Crocker Bldg., San Francisco			See South Spring Hill.
Sunset	9	5 N.	11 E.				
Sutter Creek				Keystone Mining Co.			
Talisman							

Telegraph Hill													XIII, p. 77.
Tellurium	33	7 N.	12 E.		W. S. Straub, Oakland		2,400	20					XII, p. 79; XIII, p. 77; XIV, p. 49.
Tierakoff	32	7 N.	13 E.		W. A. Marchand, Defender								XII, p. 92; XIII, p. 77; XIV, p. 49. See Belmont.
Treadwell													
Treasure	25	7 N.	10 E.		Treasure Mining Co., Corp., 575 Mills Bldg., San Francisco; E. S. McCurdy, Secretary		1,000	22					XIII, pp. 77-78; XIV, pp. 49-50; XVII, pp. 411-412; XVIII, p. 300; XIX, p. 16.
Tripp	10	5 N.	11 E.		H. T. Tripp, Jackson								XIII, p. 78.
Triumph	6	6 N.	11 E.		C. R. Downs, Sutter Creek								See Golden Eagle.
Union Cons.													See Clinton Cons.
Valparaiso	10	5 N.	11 E.		D. Boro, E. Garibaldi, Jackson, et al., Valparaiso Mining Co., Jackson		980	36					VIII, p. 42; XII, p. 79; XIII, p. 78; XIV, p. 52.
Velvet													
Victoria	11, 24	7 N.	10 E.		Charles Hagberg John Dixon, c/o R. D. Dixon, 425 Fourth St., Santa Rosa			20					X, p. 105.
Volunteer													
Wabash	6	6 N.	11 E.		Wabash Mining Co., c/o Webb Smith, Jackson								XIV, p. 52.
West Eureka	7	6 N.	11 E.		John Ross, E. D. Botta, Sutter Creek, et al.		1,220	15					XVIII, p. 301
West Side													See Middle Bar Group.
Wetzler													See Ama Oro.
Whitmore													
White Mountain	19	7 N.	12 E.		J. P. Treanor, 454 California St., San Francisco			15					X, p. 110.
White	21	6 N.	11 E.		Chicizola Estate Co., Jackson								VIII, p. 75; X, p. 101; XI, p. 144; XII, p. 80; Bull. 18, pp. 65-71.
Wildcat	9	6 N.	11 E.		(Part of Lincoln Consolidated)								XII, p. 80; XIII, p. 79.
Wildman													X, p. 118.
Wolverine													X, p. 118.
Wyomea	2	7 N.	10 E.										
Yellow Jacket	35	8 N.	10 E.										
Zeile (Zeila)	14	7 N.	10 E.		Kennedy Mining and Milling Co., Clunie Bldg., San Francisco								VI, pp. 22-23; VIII, pp. 22, 68, 85, 88; X, pp. 68, 104; XI, p. 139; XII, p. 80; XIII, p. 79; XIV, p. 52; Bull. 18, pp. 45, 50.
Zumwalt	28	6 N.	11 E.				1,400	260					XII, p. 79; XIII, p. 79.

*Ownership given in this table is that shown in the county tax records.

GOLD (PLACER MINES).

Placer mining has become almost a thing of the past in Amador County. The last important operations were between 1904 and 1923, when the *American Dredging Company* operated three gold dredgers on Mokelumne River from Lancha Plana downstream for nine miles. Part of this ground was in Amador County.

The gravel was from six to 35 feet deep, with an average depth of 20 feet, carried a heavy overburden, and lay on the usual lava-ash false bedrock. Two dredgers had buckets of 6-cu. ft. capacity and one had 9-cu. ft. buckets. The smaller dredgers handled usually about 125,000 cubic yards apiece monthly and seemed better adapted to the shallow ground than the larger one. The cost of operation was less than in Oroville and the yield was also lower, averaging under 10 cents a cubic yard. This company had a total of 450 acres of land.



Dredger Field, near Lancha Plana, formerly worked by American Dredging Company.

Recently plans have been made to organize a stock company and build a small dredger to work some land remaining at Lancha Plana.

Hydraulic mining has been on a limited scale in the county in recent years.

Clark Gravel Mine near Oleta has lately been examined, with the possibility of some work being done. Address. Wm. D. Clark and F. M. Clark, Oleta.

Cleveland Placer Claim, adjoining the Elephant on the west, has an adit 2400 feet long and made some production eight years ago, but lately has been idle. Address, F. Garibaldi and F. Devencenzi, Volcano.

Elephant Hydraulic Mine, near Volcano, was worked in 1922-23, and a moderate production was made. The debris restraining dam for this property is nearly filled and little piping has been done for several years. At present the property is in part under lease to Valentine

Giuliani and sons and Chester Bonneau. A little drifting was being done when visited in March, 1927, and a hole in the bedrock was being cleaned out. This mine has sufficient water for piping from about January 1 to the end of the wet season. It has a bedrock cut 125 feet long and about 500 feet of 3 ft. by 3 ft. flume. Address, J. W. Preston, Jr., 350 Post Street, San Francisco.

Leoni Claim, $3\frac{1}{2}$ miles south of Oleta, has lately been prospected by Myers and others of Plymouth. This is a drift prospect.

Loafer Hill Claim has been prospected by Joe Casper, Oleta. It is a drift claim near that place.

Ludekins Hydraulic Mine near Pine Grove has been nearly worked out and lies idle now as water is no longer available.

Union Flat Hydraulic Mine, one-half mile north of the Elephant Mine, still has a few small pieces of gravel left. The lessees of the latter property worked the Union Flat about three weeks this season.

Upton Drift Mine near Oleta was last worked by Charles Crane of Oleta. He was unable to make it pay. The high ground on the rims paid well in this district, but the deeper ground is said to be generally unprofitable.

Wicker Hydraulic Mine near Lancha Plana has been worked on a very small scale by Edgar Ekel for many years.

There are those who claim that considerable good gravel remains unworked in the Oleta and American Hill districts, but there is no authentic record of past operations. Most of the ground worked was drifted in early days, and it is known to have paid well.

In the Defender district there is an unprospected deep channel which at present is on land patented for agricultural purposes. There is a length of perhaps three miles of this, regarding which little is known.

IRON ORE.

Impure hematite, for the most part in small, unimportant bunches, occurs at places on the surface, associated with the Ione formation or as boulders and pebbles in the soil overlying it. The largest such deposit is two miles west of Ione. It has not been developed. Near Clinton, east of Jackson on the road to Pine Grove, iron ore of better grade, said to carry 55% iron, occurs.

LIMESTONE AND MARBLE.

The largest areas of limestone (in part changed to marble) in the county are at Volcano, and $3\frac{1}{2}$ miles northwest of there. The first area is reached by 14 miles of good road from Martel station, but the second is considerably farther from railroad. Neither area has been developed. A great number of comparatively small lenses of limestone occur in the western area of Calaveras schists which extends across the county from Mokelumne River northwest, west of the Mother Lode. The old *Amador County Lime Kiln*, four miles northeast of Ione, was on one of these.

Small marble quarries have been opened near Pine Grove and $2\frac{1}{2}$ miles east of Plymouth. A beautiful red marble and a serpentine

veined by magnesite, forming a stone of the 'verde antique' type, lie undeveloped west of Drytown.

Amador Marble Quarry is $2\frac{1}{2}$ miles east of Plymouth in the canyon of a north fork of Dry Creek. The deposit was opened years ago about 100 feet wide and 100 feet high, but has been idle recently. It is a gray and blue clouded stone. The quarry is about 13 miles from the railroad station of Carbondale. Alessio Dalporto, Plymouth, owner.

Carrara Marble Quarry is about four miles by road northwest of Pine Grove on the south side of the canyon of Sutter Creek, and 12 miles by road from Martell railroad station. A body of white marble, irregularly veined and splotched with blue, has been stripped on the canyon side for a width and height of about 150 feet. The quarry is worked in the dry season by C. Dondero, who ships the stone for use in San Francisco. Blocks of good size are taken out and shipped in the rough state. There is a small derrick and engine for handling the blocks.

Near *Volcano* and adjoining the Elephant hydraulic mine, James Cosgrove, Jackson, has a 20-acre placer claim, and John Rossi of Sutter Creek and other parties have 40 acres covering parts of the large area of limestone and marble near the corner common to Secs. 14, 15, 22 and 23, T. 7 N., R. 12 E. The stone is in places a white marble with tree-like black veining. It forms the bedrock of the old placer diggings and in places the rim of the old channel, and has been deeply guttered by erosion. No work has been done here.

Wait Marble Deposit is three miles west of Drytown and eight miles by road from Carbondale railway station. A hard, durable marble, having a beautiful cherry red color when polished, outcrops near the road over an area of 160 by 400 feet. The surface of the deposit is flat. The only work done has been one drill hole which was put down about three years ago by California Slimes Company, under the direction of W. E. Darrow. This hole is 46 feet deep, and is reported to show the marble all the way and in the bottom.

Near the red marble there is a small outcrop of the 'verde antique' type, serpentine veined by magnesite, on which nothing has been done.

MANGANESE.

During the war period between 1915 and 1919, several manganese prospects were worked on a small scale in this county, and there was some production. There is no record of activity in this line since 1919.

The following properties were mentioned in our Bulletin 76, Manganese and Chromium in California:

Crocker-Preston property is in the SW $\frac{1}{4}$ of Sec. 35, T. 7 N., R. 12 E., M. D. M., a mile and a half south of Volcano, and is owned by M. I. Crocker and J. W. Preston, Jr., 350 Post Street, San Francisco. It is 12 miles from Martel railroad station.

Lenses of manganese ore, some resembling deposits from mineral springs, occur in a mineralized zone at least 100 feet wide on contact between limestone and schist. Good grade ore was found, and some of it was mined.

L. Everett, Mokelumne Hill, reported an undeveloped manganese prospect four miles east of Pine Grove, which is 10 miles from Martel station, by good road.

Lee Peyton and others had a lease in 1918 on a prospect of manganese ore one-half mile north of the Crocker-Preston property, in the NW $\frac{1}{4}$ of Sec. 35. Some ore was mined.

Ruhser & Huberty had a deposit of manganese ore one-half mile southeast of Defender. It was worked by the Manganese Company of California in 1916 and it is reported that 250 tons of ore were shipped that year. Defender is 19 miles from Martel, the nearest railroad point.

Stirnman Ranch. Owner, Mrs. L. E. Blakemore, 401 McDonnell, Ave., Stockton. It is in S $\frac{1}{2}$ of SE $\frac{1}{4}$ Sec. 25, T. 7 N., R. 12 E., about 17 miles from Jackson via the Silver Lake road. This manganese prospect has not been visited by a representative of this bureau.

MINERAL PAINT.

At many places overlying the sand and clay of the Ione formation, red and yellow iron oxides occur. Most of this material is red oxide, mixed with more or less clay and sand. Very few places were noted where this material was in quantity sufficient to be of commercial interest or of high enough quality. It is in the form of concretions, on the surface or mixed in the soil.

Some of the piles of chlorination tailings resulting from the treatment of gold-bearing sulphides at mines along the Mother Lode years ago would be suitable for paint.

PLATINUM GROUP METALS.

On the Mokelumne River from near Lancha Plana downstream beyond the westerly county line, considerable dredging has been done and this yielded a little of the platinum group metals. The American Dredging Company operated three dredgers here between 1904 and 1923. The relative proportion of platinum was lower than on other streams farther north. The annual production was 20 to 25 ounces. No analysis of the product could be obtained, but the platinum content was thought to be about 50% and most of the remainder was probably osmiridium. There is no output of these metals now.

SANDSTONE.

O'Neal (Barnett) Sandstone Quarry is in Sec 27, T. 5 N., R. 10 E., 10 miles by road from a point on the railroad near Ione, and a mile south of the Buena Vista and Lancha Plana road.

This quarry was worked 40 years ago and furnished stone for such buildings as the California National Bank, Sacramento, the old Chronicle Building, in San Francisco, and others. It has lain idle a long time. Some activity was promised in 1924, but did not materialize.

The sandstone outcrops for 450 feet in length on top of a hill and is covered by 25 feet of soft white sand and gravel. It is of a pleasing red color. On the east end, a face 100 feet long by 15 feet high was opened in the old work. On the west the face of stone is about 20 feet

high and cross-bedding planes, on which the stone splits, are not nearly as prominent as on the east. Here it has been worked back for 40 feet.

On the west end of the same hill, perhaps 500 feet west of the red beds, is a face of beautiful white sandstone about 100 feet long by 10 feet high, covered by six to 10 feet of gravel. It is softer than the red stone and shows some white mica. There is no equipment at the quarry.



SAN FRANCISCO FIELD DIVISION.

C. McK. LAIZURE, Mining Engineer.

SOLANO COUNTY.

Solano, named after a former chief of the Suisun tribe of Indians, is another of the original twenty-eight counties created by an act of the first legislature in 1850. The only change of importance in its boundary lines was made in 1853 when Mare Island, lying opposite Vallejo, was transferred from Sonoma to Solano County. A few years later some minor changes were made in both the eastern and western line, but with little loss or gain in area. Since 1857 its boundaries have remained as they are today.

Geography.

Radiating in a northeasterly direction from San Pablo Bay, an arm of San Francisco Bay, Solano County is bounded on the west by Napa County, on the north by Yolo, and on the east in part by Yolo and Sacramento. Contra Costa County lies on the south, Sacramento River, Suisun Bay and Carquinez strait forming the dividing line. Solano County contains 822 square miles of land area and its population is 40,602 (1920 census). About 80% of the land is tillable and 20% mountainous and nontillable.

Besides river and ocean transportation facilities, the main line of the Southern Pacific railroad passes through the county, with branches to Sonoma and Napa valleys in adjoining counties. San Francisco-Sacramento Railroad Company's lines (electric) likewise traverse the county and the San Francisco, Napa and Calistoga Electric railway terminates at Vallejo. The latter city is also on a main state highway. Mare Island Navy Yard employs about 5000 men and Vallejo, with a population of 20,000, is the principal industrial city. Fairfield is the county seat.

Grains, fruits, nuts and alfalfa are readily grown and general farming, dairying and stock-raising are important pursuits. Its chief mineral products are cement and miscellaneous stone. Quicksilver is the only metal of commercial value found here, but its mineral resources also include brick, clay, fuller's earth, mineral water, natural gas, onyx and salt. Small amounts of chromite have been noted.

Topography.

Sulphur Springs ridge, Vaca Mountains and Blue Mountains, which the western boundary closely follows from south to north, form the principal mountainous area. Potrero hills and Montezuma hills are isolated high lands along the southern boundary. The remainder of the county is nearly all level valley and delta land. Drainage is to south and east, mainly through Putah creek and Suisun creek into Sacramento River.

Geology.

The belt of Cretaceous sandstones and shales bordering Sacramento Valley on the west terminates at the south near Fairfield. This formation occupies the hilly northwest corner of the county. There is another small area of the Cretaceous in the range of hills north of

Vallejo and Benicia. Sedimentary beds of Tertiary age flank this area on the north and east and also appear in the hills southeast of Fairfield. Extending north from Benicia, passing west of Fairfield and thence swinging west into Napa Valley the ridges are capped with a lava flow, probably of late Tertiary age. The rest of the county is covered with Recent alluvium; unconsolidated sands, gravels and clays, characteristic of the great valley floor.

MINERAL RESOURCES.

Solano first entered the list of mineral producing counties in 1860 with a natural hydraulic cement rock mined near Benicia. In 1873 the production of quicksilver began at the St. Johns Quicksilver Mine and this property has remained active at intervals up to 1923. It was not, however, until 1900, when the production of portland cement began, that the value of its mineral production exceeded a few thousands of dollars annually. From 1900 to 1925, inclusive, the county has produced more than \$1,000,000 annually, giving a total output from 1873 to 1925, inclusive, of approximately \$45,000,000. Solano's mineral production in 1925 was valued at \$2,678,547 and it ranked fourteenth among the counties of the state.

Its resources have been described in earlier reports and bulletins of the State Mineralogist; the quicksilver deposits particularly in Bulletin No. 78, 1918, and the petroleum possibilities in Bulletin No. 89, 1921. The last general survey was made in 1920 and embodied in Report XVII of the State Mineralogist.

The present report is an endeavor to bring these data up to date in conformity with the new series of county reports begun in 1925.

The table herewith gives the detailed record of mineral output from 1873 to 1925, inclusive. No figures are available prior to 1873, although production began in 1860.

BRICK AND CLAY.

The only clay being produced in the county is that mined by the Pacific Portland Cement Company for use in the manufacture of cement at the company's plant at Cement. This clay material is dug by steam shovel from beds adjacent to the mill.

In former years a number of clay working plants, including a pottery at Benicia and brick and tile plants at Vallejo, were active for a time.

The Steiger Brick and Tile Company was the last to operate. The property which this company undertook to exploit is situated at tide-water two miles northwest of the center of Vallejo. Improvements were made in the kilns and plant and an excellent quality of brick and tile produced for a time, but mismanagement of the company's affairs resulted in the suspension of operations in the latter part of 1923. An analysis of the yellow shale on the property is reported as follows:

Loss on ignition (moisture and carbonic acid)-----	8.03%
Silicia -----	57.83%
Alumina -----	19.52%
Iron oxides -----	7.46%
Calcium oxides -----	1.24%
Magnesium oxides -----	2.06%
Alkalies (balance) -----	3.86%
	<hr/> 100.00%

SOLANO COUNTY 1873-1925.

Year	Quicksilver		Mineral water		Lime and limestone		Miscellaneous stone ¹ , value	Natural gas, value	Miscellaneous and unapportioned		
	Flasks	Value	Gallons	Value	Tons	Value			Amount	Value	Substance
1873	1,800	\$144,594									
1874	1,900	199,842									
1875	2,100	176,715									
1876	1,683	74,052									
1877	1,463	54,570									
1878	802	26,386									
1879	1,290	38,507									
1880	492	15,252									
1881											
1882											
1883											
1884											
1885											
1886											
1887											
1888											
1889											
1890											
1891											
1892											
1893											
1894					6,400	\$8,000	\$225				
1895					4,300	4,635	19,650				
1896			3,094	\$1,547	5,477	5,989	15,752		75 tons	\$125	Pottery clay.
1897					9,608	9,801	20,975		400 tons	500	Pottery clay
1898					6,125	5,570	15,065				
1899			20,000	4,000		356	12,181				
1900			20,000	4,000	1,800	1,800	18,900				
1901			17,800	4,450		5,950	2,200				
1902	42	1,890	10,000	4,000			14,250		75,000 bbls.	150,000	Cement.
1903	100	4,100	10,000	4,000			21,514		250,000 bbls.	375,000	Cement
1904	377	15,080	10,000	4,000			11,113				
1905	542	18,518	10,000	4,000	100,000	100,000	78,573				
1906	528	19,272	4,000	4,000			143,487				
1907	640	24,422	40,000	4,000			202,146	\$6,584	125 tons	600	Salt.
1908	764	33,294	140,000	11,600			527,319	8,053	3,000 M.	25,000	Brick.
									400 tons	2,800	Salt.
									1,000 M.	7,000	Brick.
									100 tons	200	Salt.
1909			32,650	5,490			176,813	7,538	1,600 M.	20,000	Brick.
									5,600 tons	11,200	Clay.
1910			32,400	3,960			241,949	9,100	50 tons	150	Salt.
1911			30,000	4,000			181,952	8,596	100 tons	300	Salt.
									500 M.	4,000	Brick.
1912			285,050	44,000			130,445	8,528	50 tons	100	Salt.
									2,200 M.	20,000	Brick.
1913			23,600	3,440			28,915	7,366		13,570,019	Unapportioned, 1900-1913, inclusive.
1914	320	15,696	43,020	5,208	86,128	86,128	71,288	5,546		1,500,000	Other minerals.
1915	3		64,200	8,000			37,576	3		1,290,347	Cement, fuller's earth, natural gas, quicksilver, salt.
1916	660	61,710	11,200	3,750			49,711	3		1,090,164	Cement, natural gas, salt.
1917	554	52,765	10,960	2,580			39,826	3		1,804,060	Cement, fuller's earth, natural gas, salt.
1918	593	59,122	11,440	2,722			30,124	3		1,378,758	Cement, fuller's earth, natural gas, onyx, salt.
1919	3		3				44,156	3		1,627,928	Cement, fuller's earth, mineral water, natural gas, quicksilver.
1920	3		3		3		3	3		2,930,614	Cement, limestone, onyx, mineral water, natural gas, quicksilver miscellaneous stone.
1921			3				60,604			2,969,594	Cement, mineral water, onyx.
1922			3				103,394			3,004,720	Cement, mineral water, onyx.
1923	3		3				113,545			3,263,340	Cement, mineral water, onyx, quicksilver.
1924			3				117,475			2,972,000	Cement, mineral water, onyx.
1925			3				145,484			2,678,547	Cement, mineral water, onyx.
Totals	16,650	\$1,035,787	829,324	\$132,747	219,838	\$228,229	\$2,677,007	\$61,311		\$40,697,066	

¹Includes crushed rock, rubble, paving blocks, sand, gravel.

²Flasks of 75 pounds since June, 1904; 76½ pounds previously.

³See under 'Unapportioned.'

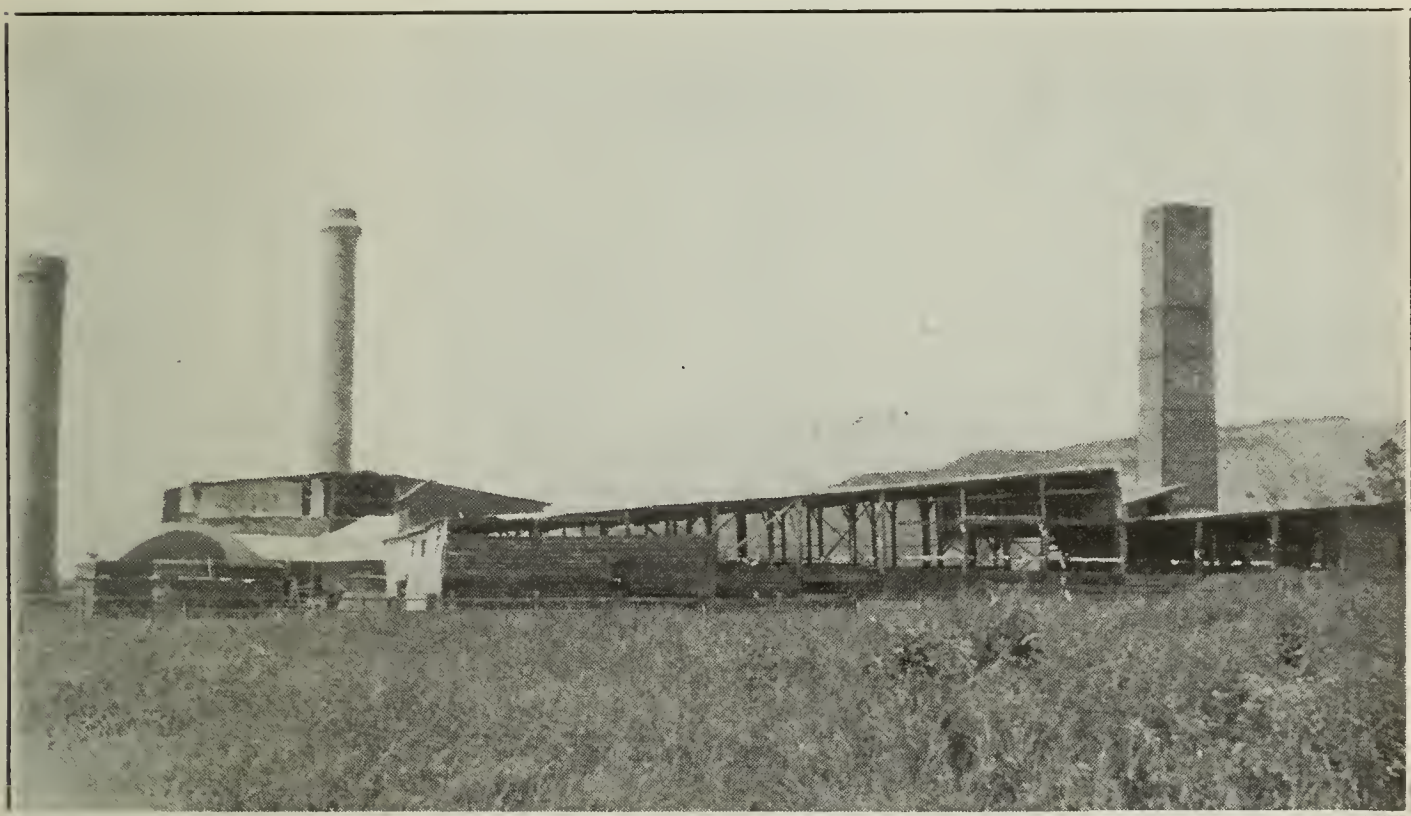
Clay from a bank at the base of the hills near Goodyear station was utilized about 20 years ago in a Benicia pottery, since abandoned.

Although there does not appear to be deposits of high-grade clay of special commercial value in the county, there is apparently an abundant supply of the more common clays adaptable to the manufacture of brick and tile.

Bibl: State Mineralogist's Report VIII, p. 631; XIII, p. 619; XIV, p. 300; XVII, p. 242. State Mining Bureau Bull. 38, p. 258, Prel. Rep. No. 7.

CEMENT.

Portland cement has been the leading mineral product of Solano County for the last 25 years. The Pacific Portland Cement Company, which was organized in May, 1901, completed their first mill of 1600



Steiger Brick and Tile Company's Plant, Solano County. Idle.

barrels daily capacity at Cement in this county in 1902. The original plant has been rebuilt and expanded at intervals, the present mill having a capacity of 4200 barrels per day.

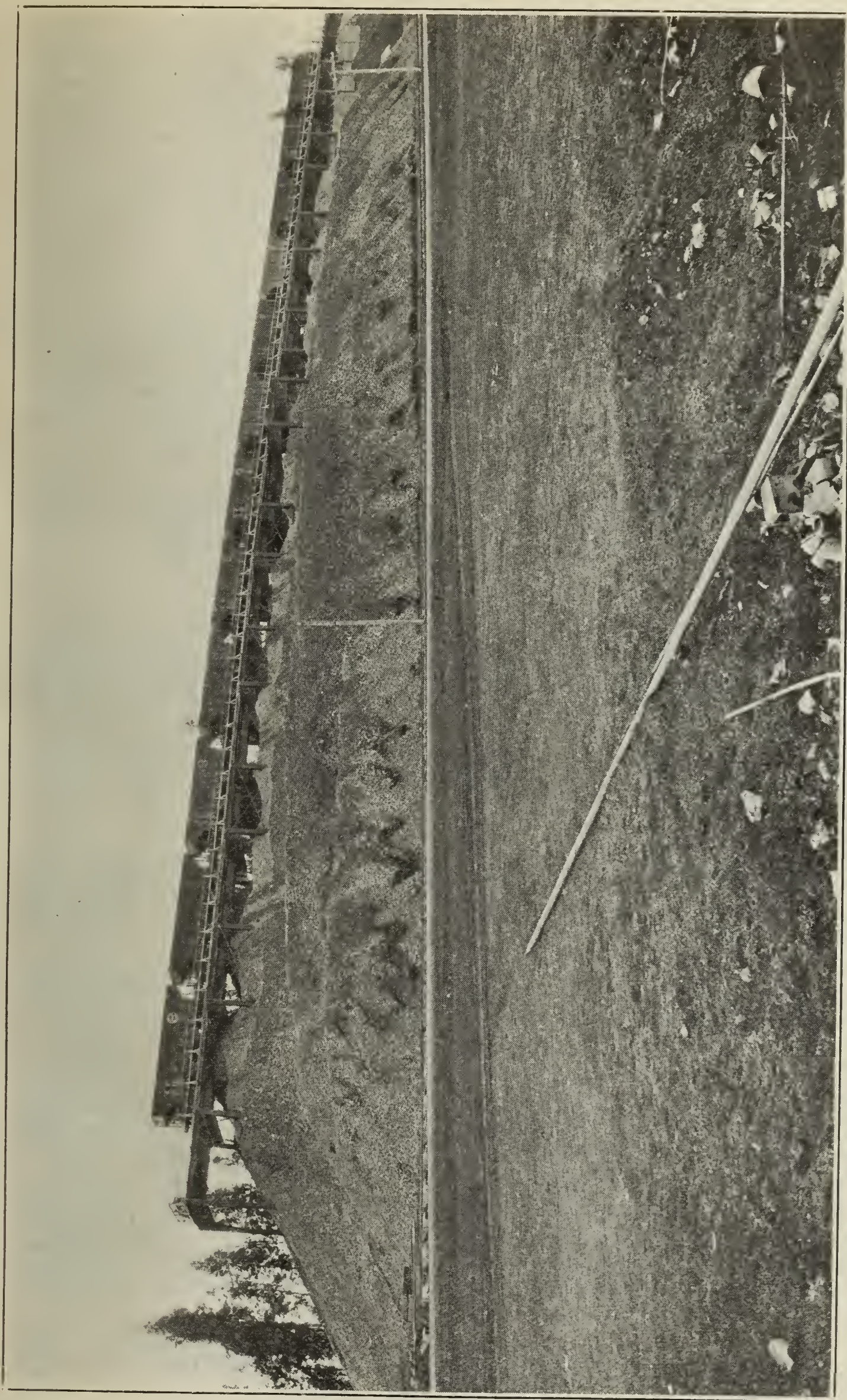
Pacific Portland Cement Company. Head office, Pacific Building, San Francisco. Robt. B. Henderson, president; J. H. Colton, vice president, in charge of operations.

This company now has three cement plants and two plaster mills, together with extensive deposits of limestone, gypsum, clay and other raw materials required in the manufacture of its products which are known by the trade names of Golden Gate and Old Mission brands of cement and Empire brand plaster. The cement plants are located at Cement, Solano County; Redwood City, San Mateo County, and San Juan, San Benito County (formerly Old Mission Portland Cement Co.). The gypsum mills are at Plaster City, Imperial County, Cal., and Gerlach, Nevada.

The Solano County cement mill is situated in the town of Cement, which is connected with the main line of the Southern Pacific railroad



Pacific Portland Cement Company's Mill, at Cement, Solano County.—Photo by courtesy of the company.



Raw Limestone Storage Pile at Pacific Portland Cement Company's Plant, Cement, Solano County.—Photo by courtesy of the company.

by the company's Cement, Tolenas and Tidewater railroad, a standard gauge line.

The dry process of manufacture is used at this plant. Some low-grade limestone remains in the deposit at the plant site, but all the limerock now being used is shipped in from the company's mountain quarries on the Middle Fork of the American River in El Dorado County, seven miles from Auburn. The output of these quarries has amounted to more than 1000 tons per day for the past 10 years. The clay used is dug locally and the gypsum required as a retarder is shipped in from the company's plant at Gerlach. Eleven short kilns are used, varying in length from 80 to 100 feet. The mill is operated by electric power, about 3500 horse power, supplied by the Pacific Gas and Electric Company, being required. The capacity of the plant is 4200 barrels per day and 90,000 barrels storage capacity is provided. Three hundred men are employed. The town of Cement closely approaches an ideal industrial center and little labor turnover results. M. J. Johnson is plant superintendent.

Bibl: State Mineralogist's Report X, p. 670; XII, p. 395; XIII, p. 632; XIV, pp. 302-307; XVII, p. 243; State Mining Bureau Bull. 38, pp. 185-189. Geol. Sur. of Cal., Geol., Vol. I, p. 104. U. S. Geol. Sur. Bull. 243, p. 120; Bull. 522, pp. 118, 121.

CHROMITE.

Chromite is reported to occur near Fairfield. A specimen in the Bureau Museum is said to have come from that locality, but the extent of the deposit is unknown.

Bibl: State Mineralogist's Report IV, p. 137; VI, p. 101; VIII, p. 632; XIV, p. 307. State Mining Bureau Bull. 38, p. 363.

COAL.

An occurrence of lignite coal has been noted in the southwestern part of the county in the hills adjacent to Goodyear station. The vein which has only been exposed for a short distance is six inches in thickness.

Bibl: State Mineralogist's Report VI, p. 118; VII, p. 151; XIV, p. 307. Geol. Sur. of Cal., Geol. Vol. I, p. 106.

FULLER'S EARTH.

This term includes many kinds of unctuous earths. They are used in the clarifying, filtering and decolorizing of mineral, animal and vegetable oils, de-inking of newspapers and many other special uses.

Old Rocky Ranch Deposit. This property comprises 166 acres lying immediately north of the holdings of the Standard Oil Company. Fuller's earth, undoubtedly a continuation of the beds exposed farther south, occurs on the ranch. The deposit has not been developed. Estate of Dr. L. C. Marshall, owner, Vacaville, Cal.

Bibl: State Mineralogist's Report XIV, pp. 307-309; XVII, p. 243. State Mining Bureau Bull. 38, p. 273. U. S. Geol. Sur. Bull. 315, pp. 268-290; Bull. 365; 475. Min. Res. 1907, 1911, 1912. U. S. B. of M. Bull. 71.

Standard Oil Company's Deposit. A deposit of white to light gray colored Monterey shale which outcrops about one-half mile northwest of the railroad station at Vacaville has been utilized in the past as fuller's earth. The deposit was originally opened up by the Western Fuller's Earth Company. Later, 34 acres covering the principal exposures were purchased by the Standard Oil Company of California. A small house was erected, a well put down and several carloads of the material were mined and shipped during 1918 and 1919. Since then there has been no activity.

MINERAL WATER.

Blue Rock Springs. (Vallejo White Sulphur Spring.) Owner, Manuel Madrid, Vallejo. These sulphur springs are in Sec. 10, T. 3 N., R. 3 W., five miles northeast of Vallejo. The main spring is stated to have a flow of about 100,000 gallons per twenty-four hours. The water is bottled and sold under the name Blue Rock Water. There is a swimming pool, hotel and camping accommodations.

Bibl: State Mineralogist's Report XII, p. 347; XIII, p. 520; XIV, p. 310; XVII, p. 246. U. S. Geol. Sur. Bull. 32, p. 209; Water Supply Pap. 338, p. 255. W. Anderson (op. cit.), p. 260.

Tolenas Springs. These carbonated springs are situated six miles north of Fairfield. The onyx marble found here is undoubtedly a result of deposition from the carbonated springs near which the water still issues. This water has not been commercially used for many years, although it was at one time bottled for sale. There are no accommodations for guests.

Bibl: State Mineralogist's Report VI, p. 74; X, pp. 668, 670; XII, p. 346; XIII, p. 521; XIV, p. 309. State Mining Bureau Bull. 24, p. 138. U. S. Geol. Sur. Bull. 32, p. 209; Water Supply Pap. 338, pp. 162-163. Mineral Springs and Health Resorts of Cal., W. Anderson, p. 255.

NATURAL GAS.

Well-defined gas blows have been noted in Secs. 11 and 14, T. 5 N., R. 1 W., and numerous seepages of gas occur along the edge of the marsh bordering Suisun Bay from Benicia northeastward for seven miles. Small amounts of this gas are used locally for cooking by the duck clubs and ranchers. Commercial production of natural gas was made for a number of years from a well drilled in 1901 by the Rochester Oil Company in the NE $\frac{1}{4}$ Sec. 24, T. 5 N., R. 1 W. This well reached a depth of 1820 feet. Gas was encountered at 1520 feet and the well produced at the rate of 20,000 cubic feet per day for several years. The gas was delivered to Suisun, Fairfield and Cement through pipe lines under its own pressure, but by 1920 the gas flow had nearly ceased as the well had been neglected and there has been no commercial output since then.

Bibl: State Mineralogist's Report VIII, p. 185; X, pp. 659-660; XIII, p. 569; XIV, p. 310; XVII, p. 246. State Mining Bureau Bull. 3, p. 5; Bull. 89, pp. 52-55.

ONYX MARBLE.

Deposits of travertine and aragonite, also referred to as onyx marble or 'Suisun' marble, occur in the vicinity of Tolenas Springs, six miles north of Fairfield. Some of the material shows a beautiful banded and wavy structure. Similar 'marble' comprises the principal limestone deposit at Cement owned by the Pacific Portland Cement Company, originally utilized in the manufacture of cement. The travertine at Tolenas Spring deposit has been quarried from time to time and used in the making of terrazzo and for other ornamental purposes. The deposit was last leased to S. Miletin, 121 Fourteenth Street, San Francisco. No material has been taken out since the latter part of 1926. A tractor used in hauling from the spring to the highway has been removed and the road to the deposit is now in poor shape.

Bibl: State Mineralogist's Report I, p. 17; IV, p. 73; V, p. 67; VI, pp. 22, 91; VIII, p. 631; X, pp. 668-670; XII, p. 403; XIII, pp. 632, 641; XIV, p. 311. State Mining Bureau Bull. 37, p. 112; Bull. 38, p. 114. Geol. Sur. of Cal., Geol. Vol. I, p. 104. U. S. Geol. Survey Water Sup. Pap. 338, p. 162.

PETROLEUM.

Two small areas in Solano County have been classified by Vander Leck¹ as 'possible' oil bearing areas; 'possible' being defined as land on which there is the slightest indication of petroleum but which remains unproven to date (1921). The indications and localities are described as follows: (a) "About one mile southeast of Cannon in Secs. 11 and 14, T. 5 N., R. 1 W., there are several well-defined 'gas blows.' These gas blows occur along the axis of a fold in the Chico sandstone, and in the vicinity of the 'blow' the rocks have been burnt to a brick-red slag. (b) In the Potrero Hills, east of Fairfield, there are numerous seepages of gas reported in the Meganos shales." The structural conditions in these two areas are regarded by Vander Leck as favorable for the accumulation of petroleum.

He further states "the unfavorable factor is the character of the formation present (contaccous) which is distinctly unfavorable for the formation of petroleum in an appreciable amount. * * * Summing these factors up, it would appear that wells drilled along the axis of the anticlines and faults * * * should obtain showing of oil and, possibly, under the most favorable conditions, obtain small quantities of oil. Whether these small quantities of oil that might be obtained would be of commercial value can only be determined by drilling. Due to the favorable structure and the large area of possible accumulation, the anticline southeast of Vacaville and the dome in the Potrero Hills may be considered as the most favorable locality to test out the district."

Subsequent to the publication of Bulletin No. 89 the two areas mentioned were drilled by the Honolulu Consolidated Oil Company without obtaining commercial production. These wells were in the

¹ Vander Leck, Lawrence, Petroleum Resources of California, with special reference to unproved areas. State Mining Bureau Bulletin 89, 1921.

SW $\frac{1}{4}$ Sec. 13, T. 5 N., R. 1 W., and in NE $\frac{1}{4}$ Sec. 9, T. 4 N., R. 1 W., respectively.

Bibl: State Mineralogist's Report XIII, p. 185; X, pp. 659, 660; XIII, p. 569; XIV, p. 311; XVII, p. 246. State Mining Bureau Bull. No. 3, p. 5; Bull. 89, pp. 49-57.

QUICKSILVER.

The known quicksilver deposits in Solano County are all located within a few miles of one another on Sulphur Springs mountain ridge in Tps. 3 and 4 N., R. 3 W. Three properties have been more or less exploited, of which St. John's mine has been the chief producer.

These deposits have been described in detail by Bradley¹ in Bulletin No. 78, which is still available. Additional data is contained in the publications listed in the bibliography herewith. To include herein detailed descriptions of the geology and workings would be a useless repetition and this report is therefore confined to notes on such changes in status as have occurred subsequent to the publication of Bulletin No. 78.

Brownlie Mine. There has been no activity at this property.

Hasting's Mine. The Hasting's Mine is in Sec. 14, T. 3 N., R. 3 W., seven miles by road north of Benicia and 4 $\frac{1}{2}$ miles in an air line north of east from Vallejo.

This property was taken under lease by Arthur G. Beck and a small group of associates, operating under the name *Hastings Quicksilver Mining Company*, in January, 1927. They immediately began cleaning out the main adit, and are now in 600 feet. Work is being continued by a small force. If sufficient ore is developed the reduction equipment at the mine will be put in working shape or new equipment placed on it. When last operated the ore being treated was yielding 1.72% mercury.

St. John's Mine. The last output of quicksilver from the St. John's Mine was made in 1923, since which time it has been idle. Most of the surface equipment has lately been destroyed by fire, and the workings are flooded.

Bibl: State Mineralogist's Report I, p. 26; VIII, p. 631; X, p. 661; XIII, p. 599; XIV, pp. 311-312; XVII, p. 246. State Mining Bureau Bull. 20, p. 19; Bull. 27, pp. 93-97; Bull. 78, pp. 171-180. U. S. Geol. Sur. Mon. XIII, p. 378; An. Rep. XXI, Pt. VI, p. 278; Min. Res. 1907-1912; Min. Res. W. of Rocky Mts. 1873, p. 10; 1874, pp. 30, 31; 1875, pp. 14, 178; 1876, p. 20. Min. & Sci. Press, Vol. 109, p. 585.

SALT.

Salt water accompanied the flow of natural gas from the well of the Rochester Oil Company in Sec. 24, T. 5 N., R. 1 W. This water was run into a shallow basin about 10 acres in extent. The salt obtained by natural evaporation of the water during the summer

¹ Bradley, Walter W., Quicksilver Resources of California, State Mining Bureau Bulletin 78, 1918.

months was harvested for several years and sold at the well, principally for salting live stock. There has been no production for about 10 years.

Bibl: State Mineralogist's Report XIV, p. 312.

STONE INDUSTRY.

For many years Solano County was an important producer of miscellaneous stone, but at the present time there are no rock quarries in operation.

The chief production has come from the quarry located on an isolated hill of basalt at the edge of the marsh land one mile east of Cordelia. This quarry has been variously known as Cordelia, Thomasson, McNaughton's and E. B. and A. L. Stone Company's Quarry. It was first opened up about 1875 and for 20 years produced principally paving blocks, for which the rock was well suited. When the demand



E. B. and A. L. Stone Company's Quarry, near Cordelia, Solano County. Idle.

for paving blocks declined the quarry was equipped with a rock crushing plant of 1000 tons daily capacity.

E. B. and A. L. Stone Company. After this company acquired the quarry the capacity of the bunkers was increased. A washing plant, pumping water from Cordelia slough, added and other improvements made. Operations continued until December, 1925, when the company became involved in financial difficulties and the plant was closed down under attachment proceedings. J. M. Nelson, superintendent, and a caretaker are in charge. Idle.

Bibl: State Mineralogist's Report X, p. 659; XII, p. 390; XIII, pp. 627, 634. State Mining Bureau Bull. 38, pp. 325, 342.

Vulcan Rock Company. This quarry is situated at Hoyt siding about one mile north of Goodyear Station and northeast of Benicia. All equipment has been removed and the property has been idle for about 15 years. It is reported that this quarry has been purchased

within the last six months and that the new owners may again open it up.

Bibl: State Mineralogist's Report X, p. 669; XII, p. 390; XIII, p. 627. State Mining Bureau Bull. 38, p. 325.

A number of other smaller quarries once active in the county are all abandoned.

LOS ANGELES FIELD DIVISION

W. BURLING TUCKER, Mining Engineer.

On account of unfinished field work there is no report from the Los Angeles Field Division in this issue.



OIL FIELD DEVELOPMENT OPERATIONS.

By R. D. BUSH, State Oil and Gas Supervisor.

From January 1, 1927, to and including April 2, 1927, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
ALAMEDA COUNTY:					
Howell and DeNormandie	--	2	2	1	
COLUSA COUNTY:					
Brown and Hihn	31	15	4	1	
FRESNO COUNTY:					
Pilot Oil Co.	12	20	14	9	Coalinga
Standard Oil Co.	35	19	15	39	Coalinga
E. H. Mitchell	22	21	15	Marland-Mitchell 1	
KERN COUNTY:					
Carneros Oil Co.	30	28	21	36	Belridge
Carneros Oil Co.	30	28	21	46	Belridge
Carneros Oil Co.	30	28	21	47	Belridge
Carneros Oil Co.	31	28	21	68	Belridge
Union Oil Co.	24	28	20	Colm 1	Belridge
Midway Northern Oil Co.	25	25	18	1	Devils Den
R. H. Sayers	25	25	18	1	Devils Den
McAdams Petroleum Corp.	2	30	22	1	Elk Hills
Union Oil Co.	26	30	24	Elk Hills 19	Elk Hills
Barnsdall Oil Co.	30	27	28	Fortine 1	Kern River
C. C. M. O. Co.	23	28	27	2	Kern River
C. C. M. O. Co.	23	28	27	3	Kern River
General Petroleum Corp.	14	28	27	18	Kern River
General Petroleum Corp.	14	28	27	21	Kern River
General Petroleum Corp.	14	28	27	26	Kern River
George F. Getty	14	28	27	Lehnhardt 1	Kern River
George F. Getty	14	28	27	Lehnhardt 2	Kern River
George F. Getty	14	28	27	Lehnhardt 8	Kern River
George F. Getty	14	28	27	Lehnhardt 13-A	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 11	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 12	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 13	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 20	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 21	Kern River
Petroleum Securities Co.	22	28	27	4	Kern River
Wonder Co., Ltd.	23	28	27	1	Kern River
Richfield Oil Co.	13	26	20	2-A	Lost Hills
Universal Consolidated Oil Co.	32	26	21	48	Lost Hills
H. H. Bell	4	30	22	2	McKittrick
McKittrick Hills Oil Co.	18	30	22	2	McKittrick
Bolsa Chica Oil Co.	1	31	22	1	Midway
C. C. M. O. Co.	21	31	22	2	Midway
C. C. M. O. Co.	27	31	22	4	Midway
General Petroleum Corp.	32	31	24	Buena Vista 12	Midway
Frank D. Gore Corp.	34	30	22	12	Midway
Honolulu Consolidated Oil Co.	8	32	24	5	Midway
Honolulu Consolidated Oil Co.	8	32	24	6	Midway
Honolulu Consolidated Oil Co.	8	32	24	7	Midway
Honolulu Consolidated Oil Co.	8	32	24	9	Midway
Honolulu Consolidated Oil Co.	8	32	24	15	Midway
Honolulu Consolidated Oil Co.	8	32	24	17	Midway
Honolulu Consolidated Oil Co.	8	32	24	19	Midway
Honolulu Consolidated Oil Co.	8	32	24	76	Midway
Honolulu Consolidated Oil Co.	8	32	24	86	Midway
Honolulu Consolidated Oil Co.	8	32	24	87	Midway
Honolulu Consolidated Oil Co.	8	32	24	88	Midway
Interstate Oil Corp.	15	32	23	Perris 6-A	Midway
A. T. Jergins Trust	15	31	22	14	Midway
Midland Oilfields Co., Ltd.	34	31	24	Thornber B-5	Midway
Midway Peerless Oil Co.	15	31	22	4-X	Midway

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued.					
North American Oil Consolidated.....	32	31	24	9	Midway
North American Oil Consolidated.....	30	31	24	43	Midway
Standard Oil Co.....	9	32	24	7	Midway
Standard Oil Co.....	9	32	24	8	Midway
Standard Oil Co.....	9	32	24	10	Midway
Standard Oil Co.....	7	32	24	21	Midway
Standard Oil Co.....	7	32	24	24	Midway
Standard Oil Co.....	7	32	24	25	Midway
Standard Oil Co.....	7	32	24	26	Midway
Standard Oil Co.....	31	31	24	27	Midway
Standard Oil Co.....	17	32	24	40	Midway
Standard Oil Co.....	29	31	24	45	Midway
Standard Oil Co.....	29	31	24	46	Midway
Standard Oil Co.....	9	32	24	46	Midway
Standard Oil Co.....	31	31	24	64	Midway
The United Oil Co.....	6	31	23	Mason 4	Midway
Barnsdall Oil Co.....	8	27	28	2	Mt. Poso
Midland Oilfields Co., Ltd.....	4	27	28	Alta Vedder 1	Mt. Poso
Shell Co.....	1	27	27	Glide 1	Mt. Poso
Shell Co.....	9	27	28	Vedder 4	Mt. Poso
Shell Co.....	9	27	28	Vedder-Rall 1	Mt. Poso
Union Oil Co.....	5	27	28	S. & M. 3	Mt. Poso
Bankline Oil Co.....	6	11	23	11	Sunset
General Petroleum Corp.....	32	12	23	Midnorth 17	Sunset
Standard Oil Co.....	10	11	23	Rass 4	Sunset
Union Oil Co.....	10	11	23	Boss 3	Sunset
Union Oil Co.....	10	11	23	Houehin 2	Sunset
Union Oil Co.....	10	11	23	Whittier-Kent 1	Sunset
Max L. Pray.....	1	29	20	1	Temblor
Standard Oil Co.....	27	11	20	Kern County	
				Lease No. 2 28	Wheeler Ridge
Standard Oil Co.....	27	11	20	Kern County	
				Lease No. 2 29	Wheeler Ridge
C. C. M. O. Co.....	23	25	27	1	-----
C. C. M. O. Co.....	28	31	22	2	-----
Elbe Oil Land Development Co.....	20	28	29	1	-----
Hoyt S. Gale.....	6	30	28	K. C. L. 1	-----
John B. Harding.....	5	10	10	1	-----
Huntington-Hawthorne Oil and Gas Co.....	35	26	18	Barry 3	-----
Milham Exploration Co.....	7	29	24	Salisbury 1	-----
Howard S. Mountford.....	18	27	19	1	-----
Muroe Development Co.....	13	29	26	Rosedale 2	-----
Zurieh Oil Co.....	18	28	22	1	-----
KINGS COUNTY:					
C. C. M. O. Co.....	17	24	19	1	-----
Milham Exploration Co.....	2	22	17	Elliot 1	-----
LOS ANGELES COUNTY:					
Shell Co.....	33	3	13	Reyes 37	Dominguez
Shell Co.....	34	3	13	Reyes 38	Dominguez
Union Oil Co.....	28	3	13	Callender 17	Dominguez
Union Oil Co.....	33	3	13	Callender 18	Dominguez
Union Oil Co.....	33	3	13	Callender 19	Domingues
Union Oil Co.....	33	3	13	Hellman 15	Dominguez
California Eastern Oil Co.....	27	2	14	Cypress	
				Heights 1	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 42	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 52	Inglewood
Standard Oil Co.....	17	2	14	L.A. Invest. 1 52	Inglewood
Standard Oil Co.....	16	2	14	Stoeker 10	Inglewood
Standard Oil Co.....	7	2	14	Vickers 1 21	Inglewood
California Eastern Oil Co.....	30	4	12	Brayton 1	Long Beach
California Eastern Oil Co.....	29	4	12	Maaser 1	Long Beach
California Petroleum Corp.....	19	4	12	Foster Two 3	Long Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Cont.					
Delaney Petroleum Corp.....	29	4	12	2	Long Beach
Delaney Petroleum Corp.....	29	4	12	5	Long Beach
Edward B. Giffen.....	19	4	12	1	Long Beach
Julian Petroleum Corp.....	28	4	12	Peacock 1-A	Long Beach
Miley Oil Co.....	19	4	12	Mills 6	Long Beach
Painted Hills Oil Assn.....	19	4	12	13	Long Beach
Shell Co.....	19	4	12	Cresson	
				Comm. 7	Long Beach
Signal Syndicate.....	19	4	12	3	Long Beach
Signal Syndicate No. 2.....	19	4	12	2	Long Beach
Union Oil Co.....	30	4	12	Long Beach	
				Comm. 15	Long Beach
The United Oil Co.....	19	4	12	Haas 12	Long Beach
McGinley Oil Co.....	6	2	11	27	Montebello
St. Helens-Riverside Properties.....	2	2	12	Monterey 14	Montebello
St. Helens-Riverside Properties.....	2	2	12	Monterey 15	Montebello
Standard Oil Co.....	2	2	12	Baldwin 70	Montebello
Union Oil Co.....	2	2	12	LaMereed 29	Montebello
Big Five Oil Co.....	18	3	13	4	Rosecrans
California Petroleum Corp.....	35	2	14	Armour	
				Morse One 1	Rosecrans
California Petroleum Corp.....	34	2	14	Sutton 1	Rosecrans
California Petroleum Corp.....	35	2	14	Toms 1	Rosecrans
Fred E. Cole.....	7	3	13	1	Rosecrans
General Petroleum Corp.....	35	2	14	Smith 1	Rosecrans
General Petroleum Corp.....	18	3	13	Vaughn 6	Rosecrans
Union Oil Co.....	18	3	13	Howard Park 34	Rosecrans
Union Oil Co.....	18	3	13	Rosecrans 9	Rosecrans
Fred A. Walker.....	35	2	14	Potrero-	
				Cypress 1	Rosecrans
Alamitos Oil Co.....	3	5	12	1	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 2	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 3	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 4	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 5	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 6	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 7	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 21	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 31	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 2	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 3	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 10	Seal Beach
Bankline Oil Co.....	3	5	12	1	Seal Beach
California Eastern Oil Co.....	3	5	12	Fueller 1	Seal Beach
California Eastern Oil Co.....	3	5	12	Graves 1	Seal Beach
California Eastern Oil Co.....	3	5	12	Horwitz 1	Seal Beach
California Eastern Oil Co.....	3	5	12	Ostaf 1	Seal Beach
California Eastern Oil Co.....	3	5	12	Person 1	Seal Beach
California Petroleum Corp.....	3	5	12	Alamitos 1	Seal Beach
California Petroleum Corp.....	3	5	12	Alamitos 2	Seal Beach
California Petroleum Corp.....	3	5	12	Alamitos 3	Seal Beach
California Petroleum Corp.....	3	5	12	Alamitos 4	Seal Beach
California Petroleum Corp.....	3	5	12	Alamitos 5	Seal Beach
California Petroleum Corp.....	3	5	12	Bailey 1	Seal Beach
California Petroleum Corp.....	3	5	12	Benton 1	Seal Beach
California Petroleum Corp.....	3	5	12	Hodges 1	Seal Beach
California Petroleum Corp.....	3	5	12	Lovell 1	Seal Beach
California Petroleum Corp.....	3	5	12	McMasters 1	Seal Beach
California Petroleum Corp.....	3	5	12	Smith 1	Seal Beach
Craburn Oil Corp.....	3	5	12	1	Seal Beach
Dominguez Extension Oil Co.....	3	5	12	2	Seal Beach
General Petroleum Corp.....	4	5	12	Wasem 1	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 2	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 3	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 4	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 5	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 6	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 7	Seal Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Cont.					
General Petroleum Corp.....	4	5	12	Wasem 8	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 9	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 1	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 2	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 3	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 4	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 5	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 6	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 7	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 8	Seal Beach
George F. Getty, Inc.....	3	5	12	S. B. 9	Seal Beach
J. Paul Getty.....	3	5	12	Alamitos Fee 1	Seal Beach
J. Paul Getty.....	3	5	12	Alamitos Fee 2	Seal Beach
J. Paul Getty.....	3	5	12	Alamitos Fee 3	Seal Beach
J. Paul Getty.....	3	5	12	Cleaver 1	Seal Beach
J. Paul Getty.....	3	5	12	Cleaver 2	Seal Beach
J. Paul Getty.....	3	5	12	Cleaver 3	Seal Beach
J. Paul Getty.....	3	5	12	Cleaver 4	Seal Beach
J. Paul Getty.....	3	5	12	Cleaver 5	Seal Beach
J. Paul Getty.....	3	5	12	Heimer 1	Seal Beach
Greene and Magee.....	3	5	12	1	Seal Beach
A. S. Johnston Drilling Co.....	3	5	12	1	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 9	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 10	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 11	Seal Beach
Marland Oil Co.....	3	5	12	Bixby 12	Seal Beach
Marland Oil Co.....	2	5	12	Bixby 13	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 15	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 16	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 17	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 18	Seal Beach
Marland Oil Co.....	11	5	12	Bixby 19	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 4	Seal Beach
Marland Oil Co.....	10	5	12	McGrath and	
				Selover 5	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 9	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 10	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 11	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 12	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 13	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 14	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 15	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 16	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 17	Seal Beach
Marland Oil Co.....	3	5	12	McGrath and	
				Selover 19	Seal Beach
Miley Oil Co.....	3	5	12	Alamitos 1	Seal Beach
Miley Oil Co.....	3	5	12	Alamitos 2	Seal Beach
N. W. Pannill.....	3	5	12	1	Seal Beach
Petroleum Securities Co.....	3	5	12	Naples 2	Seal Beach
Petroleum Securities Co.....	3	5	12	Naples 3	Seal Beach
Petroleum Securities Co.....	3	5	12	Naples 4	Seal Beach
Petroleum Securities Co.....	3	5	12	Naples 5	Seal Beach
Rainbow Petroleum Co.....	3	5	12	Gibson 1	Seal Beach
Richfield Oil Co.....	3	5	12	Bonner 1	Seal Beach
Richfield Oil Co.....	3	5	12	Doyle 1	Seal Beach
Richfield Oil Co.....	3	5	12	Reinhold 1	Seal Beach
J. T. Robertson Co.....	3	5	12	6	Seal Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Cont.					
Standard Oil Co.-----	3	5	12	San Gabriel 9	Seal Beach
Standard Oil Co.-----	3	5	12	San Gabriel 10	Seal Beach
Standard Oil Co.-----	11	5	12	San Gabriel 11	Seal Beach
Standard Oil Co.-----	11	5	12	San Gabriel 12	Seal Beach
Superior Oil Co.-----	3	5	12	Fee 1	Seal Beach
Superior Oil Co.-----	3	5	12	Fee 1 2	Seal Beach
Superior Oil Co.-----	3	5	12	Green 1	Seal Beach
Superior Oil Co.-----	3	5	12	Horwitz 1	Seal Beach
Superior Oil Co.-----	3	5	12	Kenkel 1	Seal Beach
Universal Consolidated Oil Co.-----	3	5	12	Enloe 1	Seal Beach
Universal Consolidated Oil Co.-----	3	5	12	Judson 1	Seal Beach
Universal Consolidated Oil Co.-----	3	5	12	Patterson 1	Seal Beach
Universal Consolidated Oil Co.-----	3	5	12	Wolfe 1	Seal Beach
Fred A. Walker-----	4	5	12	Jones 1	Seal Beach
Fred A. Walker-----	4	5	12	Parker 1	Seal Beach
White-Hart Oil Syn.-----	3	5	12	White-Hart 1	Seal Beach
C. C. M. O. Co.-----	17	4	14	Del Amo 70	Torrance
C. C. M. O. Co.-----	8	4	14	Del Amo 97	Torrance
Petroleum Securities Co.-----	27	4	14	Weston 1	Torrance
Spadra Oil Co.-----	34	1	9	7	-----
ORANGE COUNTY:					
Birch Oil Co.-----	2	3	10	13-A	Brea Olinda
Fullerton Oil Co.-----	2	3	10	22	Brea Olinda
General Petroleum Corp.-----	6	3	9	Tonner 8-A	Brea Olinda
Shell Co. of California-----	2	3	10	Orange 15	Brea Olinda
Union Oil Co.-----	1	3	10	Stearns 69	Brea Olinda
Union Oil Co.-----	1	3	10	Stearns 70	Brea Olinda
Chiksan Oil Co.-----	19	3	9	Herndon 1	Coyote Hills
Ahlburg Oil Corp.-----	10	6	11	Bundy 10	Huntington Beach
Ahlburg Oil Corp.-----	3	6	11	Horton 7	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Keck 8	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Lee 9	Huntington Beach
Ahlburg Oil Corp.-----	10	6	11	Mills 6	Huntington Beach
H. F. Alexander Oil Well-----	10	6	11	1	Huntington Beach
Auburn Oil Co.-----	35	5	11	1-A	Huntington Beach
Barneson & Macklin-----	10	6	11	Laughlin 1	Huntington Beach
Barry Oil Assn.-----	10	6	11	5	Huntington Beach
Bruce Oil Co.-----	34	5	11	9	Huntington Beach
Byrens Oil Corp.-----	10	6	11	1	Huntington Beach
California Petroleum Corp.-----	28	5	11	Buck 3	Huntington Beach
Walker Coan, Trustee-----	10	6	11	Topeka 2	Huntington Beach
Coastal Oil Co.-----	10	6	11	2	Huntington Beach
Frank H. Cole-----	10	6	11	3	Huntington Beach
Concord Oil Assn.-----	10	6	11	1	Huntington Beach
Crudoil Co.-----	10	6	11	2	Huntington Beach
Crudoil Co.-----	10	6	11	3	Huntington Beach
Crudoil Co.-----	10	6	11	4	Huntington Beach
Crudoil Co.-----	10	6	11	5	Huntington Beach
Crudoil Co.-----	10	6	11	6	Huntington Beach
Crudoil Co.-----	10	6	11	8	Huntington Beach
Crudoil Co.-----	10	6	11	10	Huntington Beach
J. Paul Getty-----	10	6	11	Hunt. Beh. 5	Huntington Beach
Globe Lease & Royalty Co.-----	27	5	11	2	Huntington Beach
J. E. Hall-----	10	6	11	1	Huntington Beach
Higgins & Dutton-----	10	6	11	Bundy 1	Huntington Beach
Walter W. Hoyer-----	10	6	11	1	Huntington Beach
Huntington Signal Oil Co.-----	10	6	11	7	Huntington Beach
Newton P. Jackson-----	10	6	11	1	Huntington Beach
Julian Petroleum Corp.-----	10	6	11	Treat 2	Huntington Beach
Kohlbusch and Johnston, Inc.-----	10	6	11	Pollard-	
				Callahan 1	Huntington Beach
Kohlbusch and Johnston, Inc.-----	10	6	11	Pollard-	
				Callahan 2	Huntington Beach
Lewis, Sam N.-----	10	6	11	Lewis 1	Huntington Beach
Lewis, Sam N.-----	10	6	11	Lewis 2	Huntington Beach
Harry E. MacAdam-----	10	6	11	Lester 1	Huntington Beach
J. H. McMahon, Trustee-----	10	6	11	1	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twsp.	Range	Well No.	Field
ORANGE COUNTY—Continued.					
Neal D. McPhail.....	34	5	11	1	Huntington Beach
M. M. McVey.....	10	6	11	10	Huntington Beach
Miller & Thompson.....	10	6	11	1	Huntington Beach
Leroy Moore.....	10	6	11	1	Huntington Beach
J. E. O'Donnell.....	10	6	11	H. B. 1	Huntington Beach
Olympic Refining Co.....	10	6	11	H. B. 10	Huntington Beach
Olympic Refining Co.....	10	6	11	H. B. 11	Huntington Beach
Painted Hills Oil Assn.....	10	6	11	12	Huntington Beach
Prudential Oil Corp.....	10	6	11	2	Huntington Beach
Ring Petroleum Corp.....	10	6	11	7	Huntington Beach
Fred W. Roberts.....	10	6	11	H. B. 3	Huntington Beach
Fred W. Roberts.....	10	6	11	H. B. 4	Huntington Beach
Rogers and Fietz.....	10	6	11	1	Huntington Beach
Rogers and Fietz.....	10	6	11	2	Huntington Beach
Ruether & Graham.....	10	6	11	1	Huntington Beach
San Martinez Oil Co.....	10	6	11	T. W. 1	Huntington Beach
Standard Oil Co.....	34	5	11	Bolsa 29	Huntington Beach
Standard Oil Co.....	34	5	11	Bolsa 30	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington B 57	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington B 58	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington B 59	Huntington Beach
Standard Oil Co.....	10	6	11	Huntington H 25	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 5	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 6	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 7	Huntington Beach
Superior Oil Co.....	10	6	11	Eberle 1	Huntington Beach
Superior Oil Co.....	10	6	11	Fee 5	Huntington Beach
Superior Oil Co.....	10	6	11	Nixon 2	Huntington Beach
Superior Oil Co.....	10	6	11	Walker 1	Huntington Beach
Trident Oil Co.....	10	6	11	1	Huntington Beach
Western Drilling and Producing Co..	10	6	11	1	Huntington Beach
White-Smithson Oil Co.....	10	6	11	Winckler 1	Huntington Beach
Sy Wicker.....	10	6	11	1	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 11	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 12	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 13	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 14	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 16	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 17	Huntington Beach
Wilshire Oil Co., Inc.....	10	6	11	H. B. 18	Huntington Beach
World Petroleum Corp.....	10	6	11	Mathews &	
				Berman 4	Huntington Beach
Associated Oil Co.....	33	3	9	Bayha 5	Richfield
Associated Oil Co.....	33	3	9	Kammerer 5	Richfield
Berry and Todd.....	34	3	9	Thurston 1	Richfield
California Petroleum Corp.....	33	3	9	Krug 8	Richfield
California Petroleum Corp.....	34	3	9	Richfield	
				Cons. 13	Richfield
California Petroleum Corp.....	34	3	9	Richfield	
				Cons. 14	Richfield
C. C. M. O. Co.....	33	3	9	7-R	Richfield
C. C. M. O. Co.....	33	3	9	8-R	Richfield
Continental Oil Co.....	33	3	9	5	Richfield
Continental Oil Co.....	30	3	9	Kraemer 4	Richfield
E. L. Cragen.....	28	3	9	1	Richfield
Delaney Petroleum Co.....	27	3	9	4	Richfield
General Petroleum Corp.....	33	3	9	Hugo 7	Richfield
General Petroleum Corp.....	33	3	9	Mullen 3	Richfield
General Petroleum Corp.....	33	3	9	Mullen 4	Richfield
General Petroleum Corp.....	28	3	9	Thompson 10	Richfield
Standard Oil Co.....	34	3	9	Anaheim	
				Union 2	Richfield
Standard Oil Co.....	34	3	9	Moll. Comm. 1	Richfield
Superior Oil Co.....	33	3	9	Etchandy 1	Richfield
Union Oil Co.....	29	3	9	Chapman 27	Richfield
Union Oil Co.....	33	3	9	Stern 6	Richfield
Union Oil Co.....	33	3	9	Stern 7	Richfield

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued.					
Union Oil Co.-----	33	3	9	Stern 8	Richfield
Union Oil Co.-----	28	3	9	Thompson and Goodwin 9	Richfield
Union Oil Co.-----	34	3	9	Yorba Linda Group 14	Richfield
RIVERSIDE COUNTY:					
L. R. Clark-----	5	3	2	2	-----
SAN BENITO COUNTY:					
Betabel Fruit Farm-----	Sub. B of	of Lot San A	6, Ra ntonio	necho 1	-----
SAN BERNARDINO COUNTY:					
R. A. Nickell-----	9	3	7	McCarty 1	-----
Painted Hills Oil Assn.-----	34	30	10	Peecho 1	-----
The United Oil Co.-----	10	29	17	Wreden 1	-----
SAN MATEO COUNTY:					
Shell Co.-----	8	6	5	Cowell 1	-----
SANTA BARBARA COUNTY:					
Palmer Union Oil Co.-----	30	9	32	Stendel 9	Cat Canyon
Union Oil Co.-----	--	9	34	Coast 13	Santa Maria
Smith and Barmore-----	--	4	26	4	Summerland
Miley Oil Co.-----	3	4	29	Goleta 2	-----
Miley Oil Co.-----	4	4	29	Goleta 3	-----
Levi Smith-----	3	4	29	1-A	-----
SANTA CRUZ COUNTY:					
J. R. Dorsey-----	23	11	2	Galletly 1	-----
TULARE COUNTY:					
J. W. Grafford-----	26	24	24	19	-----
VENTURA COUNTY:					
B. B. & N. Oil Co.-----	13	4	19	10	Piru
Edward A. Logsdon-----	14	4	19	King Tut 1	Piru
Schell and Jennings-----	32	4	18	10	Piru
Big Six Petroleum Co.-----	19	4	19	1	Sespe
Clampitt and Withrow-----	1	4	20	9	Sespe
H. A. Ivers-----	1	4	20	9	Sespe
H. A. Ivers-----	1	4	20	10	Sespe
R. F. Labonge-----	1	4	20	Star 6	Sespe
Shell Co.-----	33	3	20	Berylwood 2	Sini
Oak Ridge Oil Co.-----	13	3	21	Harvey 19	South Mountain
Oak Ridge Oil Co.-----	13	3	21	Harvey 21	South Mountain
Associated Oil Co.-----	23	3	23	Dabney-Lloyd 1	Ventura
Associated Oil Co.-----	22	3	23	Hartman 6	Ventura
Associated Oil Co.-----	27	3	23	Lloyd 44	Ventura
Associated Oil Co.-----	27	3	23	Lloyd 50	Ventura
Bolsa Chica Oil Co.-----	21	3	23	Louis	
				Hartman 3	Ventura
C. C. M. O. Co.-----	16	3	24	1-B	Ventura
General Petroleum Co.-----	21	3	23	Barnard 11	Ventura
General Petroleum Co.-----	28	3	23	Barnard 15	Ventura
G. J. Magenheimer-----	22	3	23	Hartman 1-A	Ventura
Miley Oil Co.-----	7	3	23	Casitas 2-A	Ventura
Petroleum Securities Co.-----	28	3	23	Orton 2	Ventura
Petroleum Securities Co.-----	28	3	23	Orton 3	Ventura
Petroleum Securities Co.-----	28	3	23	Willett 2	Ventura
Shell Co.-----	28	3	23	Edison 14	Ventura
Shell Co.-----	28	3	23	Edison 15	Ventura
Shell Co.-----	28	3	23	Taylor 17	Ventura
Shell Co.-----	28	3	23	Taylor 19	Ventura
Shell Co.-----	28	3	23	Taylor 20	Ventura
Shell Co.-----	28	3	23	Taylor 21	Ventura

SPECIAL ARTICLES.

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of 'Mining in California.'

These special articles cover a wide range of subjects, both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

MANGANESE ORE PRODUCERS' COMMITTEE.

Immediately following the adjournment of the meeting of the American Institute of Mining and Metallurgical Engineers in Cleveland, Ohio, on April 20, 1927, a voluntary committee of American producers of manganese ore was formed for the purpose of protecting and advancing the interests of domestic producers. The committee is as follows:

J. Carson Adkerson, Woodstock, Virginia.
 N. H. Mannakee, Bluefield, West Virginia.
 H. A. Pompelly, Oswego, New York.
 J. H. Cole, Phillipsburg, Montana.
 Wm. D. Meyering, City Hall, Chicago, Ill.

All persons interested in American manganese ores are advised to communicate promptly with one of the above named committee so that they may receive information and be notified of a convention to be called at an early date to advance the interests of producers of manganese ores in America.

BIBLIOGRAPHY OF CLAY DEPOSITS IN CALIFORNIA.

A new bulletin on the clay resources of the state is now in course of preparation by Mr. W. F. Dietrich, Ceramic Engineer. In the meantime there is no single publication of the State Mining Bureau in print devoted to this subject. The following compilation of references has been prepared, therefore, with the idea of offering a means of ready reference to descriptions of clay deposits reported upon in the various publications of the State Mining Bureau. All of the publications listed may be consulted in the main and branch offices of the State Mining Bureau and in many public libraries. A list of those available for distribution will be sent upon request.

California State Mining Bureau Publications Relating To Clay Deposits.

Reports.

First Report of the State Mineralogist, 1880, pp. 36-38.
 Fourth Report of the State Mineralogist, 1884, pp. 139-146.
 Eighth Report of the State Mineralogist, 1888, pp. 16, 108, 116, 159, 161, 342, 415, 529, 557, 561, 631, 635, 636, 690.

Ninth Report of the State Mineralogist, 1889, pp. 287-308.

Tenth Report of the State Mineralogist, 1890, pp. 236, 265, 314, 413, 625.

Eleventh Report of the State Mineralogist, 1892, pp. 146-149, 252, 321, 471.

Twelfth Report of the State Mineralogist, 1894, pp. 381-384.

Thirteenth Report of the State Mineralogist, 1896, pp. 612-620.

Fourteenth Report of the State Mineralogist, 1914, pp. 4, 5-11, 56, 178, 197, 204, 244, 300, 316, 367, 379, 380, 391, 392, 415, 605, 607, 629, 737, 738, 756, 816.

Fifteenth Report of the State Mineralogist, 1916, pp. 256, 260, 322-326, 424, 488-499, 559-574, 596, 630, 860, 905.

Seventeenth Report of the State Mineralogist, 1920, pp. 76, 149, 166, 184, 234, 256, 257, 307, 317, 323, 325, 338, 375, 412, 441.

Eighteenth Report of the State Mineralogist, 1922, pp. 215, 523, 554-557.

Nineteenth Report of the State Mineralogist, 1923, pp. 94-96, 164, 185-210.

Twentieth Report of the State Mineralogist, 1924, pp. 46, 368.

Twenty-first Report of the State Mineralogist, 1925, pp. 2, 29, 64-66, 167, 177, 190, 204, 236, 287, 302, 354, 505, 546, 579.

Twenty-second Report of the State Mineralogist, 1926, pp. 78, 131, 228, 268, 317, 332, 513, 560.

Bulletins.

Bulletin No. 38, Structural and Industrial Materials of California, 1906, pp. 190-259.

Preliminary Reports.

No. 7, The Clay Industry in California, 1920.

Statistics.

Statistics of Production and Value in Annual Statistical Bulletins.

California Mineral Production for 1925, and previous annual issues.



ADMINISTRATIVE DIVISION.

WALTER W. BRADLEY, Deputy State Mineralogist.

Personnel.

There have been no changes of personnel to be noted during the past quarter.

New Publications.

During the quarterly period covered by this issue, the following Bureau publications have been made available for distribution:

Mining in California (quarterly), October, 1926, being Chapter 4 of State Mineralogist's Report XXII. Price 25 cents.

Summary of Operations, California Oil Fields: Vol. 12, Nos. 4 and 5, for October and November, 1926, respectively.

Commercial Mineral Notes: Nos. 48, 49, 50, February-April (inc.). These 'notes' carry the lists of 'mineral deposits wanted' and 'minerals for sale' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'Mining in California.'

Mails and Files.

The Bureau maintains, in addition to its correspondence file and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During the period covered by this quarterly report, there were 2006 letters received and answered at the San Francisco office alone, covering almost every phase of prospecting and developing mineral deposits, reduction problems, marketing of refined products and mining law.



DIVISION OF MINERALS AND STATISTICS.

Statistics, Museum Laboratory.

WALTER W. BRADLEY, Deputy State Mineralogist.

STATISTICS.

California continues to produce commercially, as for some years past, more than 50 different mineral substances, the total value of which for 1926 was estimated at \$456,408,000 (see January issue of MINING IN CALIFORNIA, page 118, ante).

At the present writing (May 1st), reports are in hand from most of the producers. Data for several substances are now complete and have been compiled, being presented herewith.

Information at hand indicates that there was no production in California during 1926 of the following substances, which have at one time or another in the past been on the active list here: Arsenic, bismuth, fluorspar, graphite, mica, molybdenum, serpentine, sulphur, strontium, tin. There was production by a single operator in each of the following: Andalusite, antimony, asbestos, bromide, cyanite and lithia, the figures for which will have to be combined under the 'unapportioned' item in the final report. The production of bromine from salt-works bittern waters is the first, in commercial quantity, of record in California.

BARYTES.

Commercial shipments of crude barytes in California amounted to a total of 4978 tons, valued at \$38,165 f.o.b. rail-shipping point, coming from properties in Nevada and Mariposa counties. The material was consumed principally in the manufacture of lithopone. The new plant of the Chemical and Pigments Company at Oakland, Alameda County, with a capacity for 25 tons of lithopone daily, began operations during the year. This plant will thus afford an outlet for some of California's zinc ore as well as for barytes.

More than half of the total tonnage of barytes utilized in the United States is taken in the manufacture of lithopone, which is a chemically-prepared white pigment containing approximately 70% barium sulphate and 30% zinc sulphide. This is one of the principal constituents of 'flat' wall paints. Other important uses for barytes, after washing and grinding, are as an inert pigment and filler in paint, paper, linoleum, oilcloth and rubber manufacture, and in the preparation of a number of chemicals including barium binocide, carbonate, chloride, nitrate, and the sulphate precipitated, or 'blanc fixe.'

BITUMINOUS ROCK.

This material is essentially an uncemented sandstone which is saturated with and held together by a natural asphaltic constituent, probably the residue from the evaporation of a crude petroleum deposit. Bituminous rock is still used to a limited extent for road dressing in those districts adjacent to available deposits, though the manufacture of asphalt at the oil refineries has almost entirely superseded the direct use of the native material. The present operators of the old City Street Improvement Company's quarry in Santa Cruz County advise that they are now putting on the market a material which can be laid cold. It will be especially applicable and valuable for patching jobs.

Shipments from quarries in Santa Barbara and Santa Cruz counties in 1926 totaled 3863 tons of bituminous rock, valued at \$21,577 f.o.b. rail-shipping point, being an increase over the 1925 shipments.

CEMENT.

Cement is the most important single structural material in the mineral output of California. During 1926 there was produced a total of 13,797,173 barrels, valued at \$25,269,678, f.o.b. plant; being an increase of over half a million barrels in quantity, but only slightly in total value owing to a small drop in prices. The 1925 output was 13,206,630 barrels, valued at \$25,043,335, or an average of \$1.90 per barrel. The 1926 average was \$1.84 per barrel.

The 1926 production came from eleven operating plants in nine counties, and employing a total of 3047 men. The three plants in San Bernardino County made a total of 5,135,840 barrels, valued at \$9,273,627, the balance of the state's product coming from a single plant in each of the following counties: Calaveras, Contra Costa, Kern, Riverside, San Benito, San Mateo, Santa Cruz and Solano. The new plant of the Calaveras Cement Company near San Andreas, Calaveras County, began operation and commercial shipments in 1926. Recent press notices record the consolidation of the Pacific Portland Cement Corporation, operating cement plants in San Mateo and Solano counties, and a gypsum plant in Imperial County, with the Old Mission Portland Cement Company, operating at San Juan, San Benito County.

MUSEUM.

The Museum of the State Mining Bureau possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America; and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Mining Bureau as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

LABORATORY.

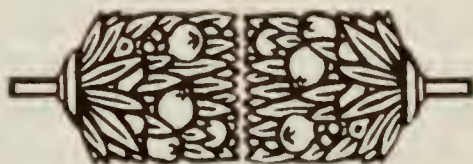
FRANK SANBORN, Mineral Technologist.

Samples of sandstone containing the black sulphide of mercury, metacinnabarite, have recently been submitted to this Bureau from near Skaggs Springs in Sonoma County. At this deposit the metacinnabarite occurs in small black amorphous masses disseminated through the rock; little or no cinnabar is associated with the black sulphide. The percentage of mercury present in this ore is apparently high enough for a commercial grade of quicksilver, provided the deposit proves to be sufficiently large. Metacinnabarite will concentrate in panning, giving a dark colored concentrate; otherwise it is an inconspicuous mineral when occurring as black specks penetrating a rock.

The most important deposits of cinnabar so far discovered in California occur in the Coast Range, extending from Del Norte County to San Diego County. Samples of black sand received from some of these counties for platinum tests usually contain a small amount of cinnabar. The present trend of prices of quicksilver and platinum metals suggests the feasibility of prospecting this territory again, not for platinum, but for quicksilver. The suggestion has been made in some of our laboratory reports that the sender attempt to find the source of the cinnabar present in the sample submitted.

The present high price of mercury has apparently stimulated the prospecting for this metal. At least one new deposit of cinnabar has been found in Napa County during the past year.

During the three-month period covered by this report samples have been received from practically every county in the state, 1159 determinations having been made.



LIBRARY.

E. A. LOWE, Librarian.

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the State Mining Bureau contains some five thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, 'Mining in California' contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED.**Governmental.****U. S. Geological Survey:**

Professional Paper No. 147—Shorter Contributions to General Geology, 1926. By W. C. Mendenhall.

Bulletin No. 783—Annual Resources of Alaska. Report on Progress of Investigation in 1924. By Philip S. Smith and others.

Bulletin No. 785—Contributions to Economic Geology (short papers and preliminary reports), 1926. Part I, Metals and Non-Metals except Fuels. By G. F. Loughlin and G. R. Mansfield.

Bulletin No. 786-B—Geology of the Cat Creek and Devil's Basin Oil Fields and Adjacent Areas in Montana. By Frank Reeves.

Bulletin No. 790-B—The Palouse Soil Problem, with an account of Elephant Remains in Wind-Borne Soil of the Columbia Plateau of Washington. By Kirk Bryan.

Water Supply Paper No. 550—Surface Water Supply of the United States in 1922; Part X, the Great Basin. By N. C. Grover.

Water Supply Paper No. 584—Surface Water Supply of the United States. By Nathan C. Grover.

Water Supply Paper No. 596-A—Methods of Exploring and Repairing Leaky Artesian Wells. By John McCombs and Albert G. Fields.

U. S. Bureau of Mines:

I:11—Manganese and Manganiferous Ores in 1925. By J. W. Furness.

I:15—Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1925. Mines Report. By Chas. W. Henderson.

I:16—Silver, Copper, Lead and Zinc in the Central States in 1925. Mine Report. By J. P. Dunlop and H. H. Meyer.

I:17—Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1925. Mine Report. By James M. Hill.

II: 3—Fuller's Earth in 1925. By Jefferson Middleton.

- II: 8—Asbestos in 1925. By Blanche H. Stoddard.
 II: 9—Slate in 1925. By A. T. Coons.
 II:10—Magnesium and Its Compounds in 1925. By J. M. Hill.
 II:13—Clay in 1925. By Jefferson Middleton.
 II:21—Talc and Soapstone in 1925. By Blanche H. Stoddard.
 II:22—Potash in 1925. By A. T. Coons.
 II:23—Stone in 1925. By A. T. Coons.
 II:25—Sand and Gravel in 1925. By Estelle R. Phillips.
 II:26—Silica in 1925. By Frank J. Katz.
 II:30—Coal in 1924. By James E. Black, L. Mann and F. G. Tyson.
 Technical Paper No. 375—Effects of the Corona Discharge on Petroleum. By J. J. Jakosky.
 No. 381—Heavy Liquids for Mineralogical Analyses. By John D. Sullivan.
 No. 383—Blasting to Lessen Boulders in Hard Ore Stopes. By E. D. Gardner and S. P. Howell.
 No. 385—Typical Methods and Devices for Handling Oil-contaminated Water from Ship and Industrial Plants. By F. W. Lane and A. D. Bauer, H. T. Fisher and P. N. Harding.
 No. 386—Explosibility of Coal Dust from Mines in Utah. By H. P. Greenwald.
 No. 387—Engine Service Tests of Internal Combustion Engine Lubricating Oils made from California Crude Oil. By Martin J. Gavin and Gustave Wade.
 No. 389—Lead Poisoning in the Mining of Lead in Utah. By Arthur L. Murray.
 No. 394—Dust Respirators. Their Construction and Filtering Efficiency. By S. H. Katz, G. W. Smith and E. G. Meiter.
- Reports of Investigations:
- Serial No. 2793—Sources of Dust in Coal Mines. By J. J. Forbes and Alden H. Emery.
 Serial No. 2794—Some Feldspathic Materials of the Pacific Northwest. By Hewitt Wilson.
 Serial No. 2795—Fifteenth Semi-Annual Motor Gasoline Survey. By E. C. Lane and Peter Grandone.
 Serial No. 2796—Coal Mine Fatalities in January, 1927. By W. W. Adams.
 Serial No. 2797—Consumption of Explosives in January, 1927. By W. W. Adams.
- Circular No. 6020—One Hundred Percent of the Employees of Two Large Illinois Coal Mines Trained in First Aid.
 Circular No. 6021—List of Permissible Mining Equipment.
- Alabama—General Summary of Mineral Production for 1924. By Walter B. Jones.
 Arizona Bureau of Mines. Bulletin 119, Geo. Series No. 3—A Resume of Arizona Geology. By N. H. Darton.
- California—
- Report of the Division of Architecture, Dept. of Public Works of State. Part IV.
 Biennial Report of the Division of Water Rights, a Subdivision of the Dept. of Public Works of the State. By Edw. Hyatt, Jr.
 Sacramento Flood Control Project, Revised Plan. Maps and Profiles.
- Connecticut—State Geology and Natural History—
- Bulletin No. 36—The Uredinales or Rusts of Connecticut and the Other New England States. By Willis R. Hunt, Ph. D.
 Bulletin No. 37—Catalogue of the Lichens of Connecticut. By Alex. W. Evans, Ph. D.
 Survey Bulletin No. 37—Catalogue of the Lichens. By Alex. Wm. Evans.
- Idaho Bureau of Mines and Geology:
- Bulletin No. 11, Dec., 1926—Geology and Metalliferous Pesomces of the Region About Silver City, Idaho. By Arthur M. Pipe and Francis B. Laney.
 Pamphlet 19, Jan., 1927—Geologic Reconnaissance of Clark and Jefferson and Parts of Butte, Custer, Fremont, Lemhi and Madison Counties, Idaho. By R. D. Kulsham.
 A Disseminated Lead Prospect in Northern Boise County, Idaho. By Clyde P. Ross.

Illinois State Geological Survey. Dept. of Registration and Education :

Bulletin No. 49, State of Illinois.

Press Bulletin No. 8—Oil Possibilities of the Alexis Quadrangle, Mercer and Warren Counties, Illinois. By Harold R. Wanless.

Press Bulletin No. 7—Illinois Petroleum. By Ben B. Cox.

Iowa Geological Survey, Vol. XXXI, Annual Reports 1923-1924, with accompanying papers. By Geo. F. Kay, Ph. D., State Geologist.

Kentucky Geological Survey. By Prof. L. C. Robinson.

New Oil Pools of Kentucky. By Willard Rouse Jillson.

Missouri Bureau of Geology and Mines. Personal Report of the State Geologist. Vol. IX, No. 4—School of Mines. Univ. of Missouri. Descriptive Bibliography on Oil Fluid Flow and Heat Transfer in Pipes. By Joe B. Butler.

North Carolina, Dept. of Conservation and Development, Div. of Forestry. Circular No. 17—Program of American Forest Week. By J. W. Sebring.

Ohio, Geological Survey of. By J. A. Bownocker, State Geologist.

Bulletin No. 30, Fourth Series—Geology of Delaware County. By Lewis G. Westgate, Ph. D.

Pennsylvania Geological Survey. Bull. M-9—Slate in Northampton County. By Chas. H. Behre, Jr.

South Dakota Geological and Natural History :

Survey Circular No. 28—Structures in Western Haakon and Eastern Pennington Counties. By Wm. Russell.

Survey Circular No. 29—A Preliminary Report of a Biological Survey of the Lakes of South Dakota. By Wm. H. Over and Edw. P. Churchill.

Circular No. 26—Sand and Gravel Deposits of Minnehaha County.

Circular No. 27—The Possibilities of Oil in Western Carson County. By Wm. L. Russell.

Circular H—Sand and Gravel Deposits of Yankton County. By E. P. Rothrock.

Biennial Report of State Geologist, 1924-26.

Tennessee, Dept. of Education, Div. of Geology :

Bulletin 32-E—Coal Losses of Tennessee. By J. J. Forbes.

Bulletin 33-A—The Southern Tenn. Coal Fields. By Wilbur A. Nelson.

Bulletin 33-C—The Coals and Geology of the Herbert Domain. By Wilbur A. Nelson.

Bulletin 33-D—Geology and Mineral Resources of the Crossville Quadrangle. By Chas. Butts and Wilbur A. Nelson.

Bulletin 36—The Valley of East Tennessee; the Adjustment of Industry to Natural Environment. By Earl C. Case.

Vermont—Report of State Geologist on Mineral Industries and Geology, 1925-26—15th of this series. Geo. H. Perkins, State Geologist.

Washington—Third Biennial Report of Dept. of Conservation and Dev. from April 1, 1925 to Sept. 30, 1926. By Earl J. Barnes, Dir.

West Virginia—Grant Counties. Paleontology of Minerals.

Canada, Dept. of Mines, Mines Branch :

No. 632—Bituminous Sands of Northern Alberta—Occurrences and Econ. Possibilities. By S. C. Ellis. Topographical Maps to accompany.

No. 679—Helium in Canada. By R. T. Elworthy.

14th Ed. Catalogue of Mines Branch Publications.

Summary Report 1925, Part B, Geological Survey.

Bulletin No. 43, Biological Series No. 11, Mar. 22, 1926. Victoria Memorial Museum. List of Mushrooms and other Fleshy Fungi of the Ottawa Dist. By W. S. O'Dell.

Bulletin No. 2113, Part C, Summary Report, 1925, Geological Survey.

No. 669—Investigations of Mineral Resources and the Mining Industry, 1925.

No. 670—Investigations in Ore Dressing and Metallurgy (testing and research laboratories).

No. 672—Investigations in Ceramics and Road Materials (testing and research laboratories).

No. 2093—Geological Series No. 3. The Iron Ores of Canada, British Columbia and Yukon. By G. W. Young.

Nova Scotia, Report on the Mines, 1926.

Quebec, Dept. of Colonization, Mines and Fisheries. Preliminary Statement on Mineral Production During 1926.

Ontario :

Bulletin No. 60—Preliminary Report on Mineral Production in 1926. By W. R. Rogers and A. C. Young. Dept. of Mines.

35th Annual Report of Ontario Dept. of Mines, Vol. XXXV, Part II, 1926.

Bulletin No. 46—(Rev. Ed., Dec., 1926).

Hydro Electric Development for Metal Mines of Northern Ontario. By A. R. Webster, inspector of mines.

New Zealand, Dept. of Internal Affairs. 59th Annual Report of the Dominion Laboratory. By J. S. Maclaurin.

West Australia :

Geological Survey Bulletin No. 88—Paleontological Contributions to Geology of Western Australia. Series VII, Nos. XIII, XIV, XV. By Rex. W. Bretnall, F. Chapman and Ludwig Glanert.

Geological Survey Bulletin No. 91—The Auriferous Lodes of the Gibraltar Dist., Coolgardie Goldfield. By F. R. Freldtmann.

Bull. de la Commission Geologique de Finlande No. 77. By J. J. Sederholm.

Transvaal Chamber of Mines. Reports of Executive Committee, Gold Producers' Committee and Collieries Committee for year 1926.

Republica Argentina Ministerio De Agricultura De La Nacion Publicacion No. 23.

Geologia Economica de los yacimientos de boratos y materiales de las cereucas. Publicacion No. 24—Contribution al conocuniento de los Fenomenos geofisicos atmosfericos.

Publicacion Nos. 25-26—Condiciones Geologicas.

Publicacion No. 27—Sohre Las Posibilidades de Una Industria Sederurgica en la Republica Argentina.

The Geology and Mineral Resources of South Manchuria.

Societies and Educational Institutions.

American Mineralogist, Journal of the Mineralogical Society of America. Vol. XII, Nos. 1, 3, 1927. By Walter F. Hunt.

Geographical Review, April, 1927.

American Institute of Mining and Metallurgical Engineers :

Vol. CVI-LXXII, inc., 1917-1925. General Alphabetical and Analytical Index Transactions of the Amer. Inst. of Mining and Metallurgical Engineers.

Vol. LXXIV—Transactions of.

Mining and Metallurgical Society of America :

Bulletin No. 162—Reports of the sub-committees on Petroleum, Chrome and Graphite in connection with the Committee on Foreign and Domestic Mining Policy, Sept., 1923. Vol. XVI, No. 5.

Bulletin No. 170—Explorations in the Gobi Desert, May-June, 1924. Vol. XVII, No. 5.

Bulletin No. 188—Study of Mineral Resources and Reserves Joint Meeting with A. J. M. E., Feb.-Mar., 1927. Vol. XX, No. 2.

The Institution of Mining and Metallurgy. No. 269, Feb., 1927. No. 271, April, 1927.

Bulletin No. 270, March, 1927.

Journal of the Western Society of Engineers, Vol. XXXII, Nos. 1, 2, 3, 1927.

Proceedings of the Engineers' Society of Western Pennsylvania. Vol. 42, No. 10, Jan., 1927. Vol. 42, No. 8, Nov., 1926.

The Canadian Mining and Metallurgical Bulletin.

The Canadian Institute of Mining and Metallurgy.

The Canadian Mining and Metallurgical Bulletin No. 180.

The Philippine Journal of Science, Vol. 32, Nos. 1, 2, 3.

The Proceedings of the American Philosophical Society. Vol. LXV, 1926, No. 5.

Proceedings of Academy of Natural Sciences of Philadelphia. Vol. LXXVII, 1926.

Estados Anidos Mexicanos, Estadistica Nacional.

Societara de Industria Comercio of Trabajo Boletin del Potroleo. Vol. XXIII, Enero D 1927, No. 1.

Records of the Australian Museum. Vol. XV, Nos. 4 and 5.

Bulletin of the Geological Institution of the Univ. of Uprala. H. J. Sjogren.

Boletin Do Museu Nacional Do Rio De Janeiro. Vol. II, No. 3, Sept., 1926.

Estradistica Nacional Revista Quincenal. Ano. III, 50, 1927, Feb., 28. Ano. III, 19, 1927, Feb. 15.
 Journal of the Faculty of Engineering Tokyo Imperial Univ. Vol. XVI, No. 12.
 Economic Geology. Vol. XXII, No. 2, March and April.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

American Petroleum Institute, New York.
 Architect and Engineer, San Francisco.
 Arizona Mining Journal, Phoenix, Arizona.
 Asbestos, Philadelphia, Pennsylvania.
 Brick and Clay Record, Chicago.
 Bulletin, Union Oil Co., Los Angeles.
 California Journal of Development, San Francisco.
 Cement, Mill and Quarry, Chicago; Illinois.
 Chemical-Engineering and Mining Review, Melbourne, Australia.
 Engineering and Mining Journal-Press, New York.
 Explosives Engineer, Wilmington, Del.
 Financial Insurance News, Los Angeles, California.
 Graphite, Jersey City.
 Journal of Electricity and Western Industry, San Francisco.
 Metallurgical and Chemical Engineering, New York.
 Mine and Quarry, Chicago.
 Mining and Engineering Record, Vancouver, B. C.
 Mining and Oil Bulletin, Los Angeles.
 Oil Age, Los Angeles.
 Oil and Gas Journal, Tulsa, Oklahoma.
 Oil and Gas News, Kansas City.
 Oil News. Galesburg, Illinois.
 Oildom, New York.
 Oil, Paint and Drug Reporter, New York.
 Oil Trade Journal, New York.
 Oil Weekly, Houston, Texas.
 Petroleum Age, New York.
 Petroleum Record, Los Angeles.
 Petroleum World, Los Angeles.
 Queensland Government Mining Journal, Brisbane, Australia.
 Rock Products, Chicago, Illinois.
 Safety News, Industrial Accident Commission, San Francisco.
 Salt Lake Mining Review, Salt Lake City, Utah.
 Southwest Builder and Contractor, Los Angeles.
 Standard Oil Bulletin, San Francisco.
 Stone, New York.
 The Record, Associated Oil Company, San Francisco.
 Through the Ages, Baltimore.

Newspapers.

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, Cal.
 Arkansas Oil and Mineral News, Hot Springs National Park (Arkansas).
 Barstow Printer, Barstow, Cal.
 Blythe Herald, Blythe, Cal.
 Bridgeport Chronicle-Union, Bridgeport, Mono Co., Cal
 Calaveras Prospect, San Andreas, Cal.
 California Oil World, Los Angeles, Cal.
 Cloverdale Reveille, Cloverdale, Cal.
 Colusa Daily Sun, Colusa. Cal.
 Daily Commercial News, San Francisco, Cal.
 Daily Midway Driller, Taft, Cal.
 Del Norte Triplicate, Crescent City, Cal.
 Exeter Sun, Exeter, Cal.

Gateway Gazette, Beaumont, Cal.
Goldfield News, Goldfield, Nevada.
Guerneville Times, Guerneville, Cal.
Healdsburg Enterprise, Healdsburg, Cal.
Humboldt Standard, Eureka, Cal.
Inyo Independent, Independence, Cal.
Inyo Register, Bishop, Cal.
Ione Valley Echo, Ione, Cal.
Lake County Bee, Lakeport, Cal.
Mining and Financial Record, Denver, Colo.
Mining Topics, San Francisco, Cal.
Mountain Democrat, Placerville, Cal.
Mountain Messenger, Downieville, Cal.
Nevada City Nugget, Nevada City, Cal.
Nevada Mining Press, Reno, Nevada.
Oatman Mining News, Oatman, Arizona.
Oregon Observer, Grants Pass, Oregon.
Oroville Daily Register, Oroville, Cal.
Petroleum Reporter, Taft, Cal.
Placer Herald, Auburn, Cal.
Plumas Independent, Quincy, Cal.
Plumas National Bulletin, Quincy, Cal.
Randsburg Times, Randsburg, Cal.
San Diego News, San Diego, Cal.
Shasta Courier, Redding, Cal.
Siskiyou News, Yreka, Cal.
Stockton Record, Stockton, Cal.
Tuolumne Prospector, Tuolumne, Cal.
Ventura Daily Post, Ventura, Cal.
Weekly Trinity Journal, Weaverville, Cal.
Western Sentinel, Etna Mills, Cal.



PRODUCERS AND CONSUMERS.

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of MINING IN CALIFORNIA, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes.'



EMPLOYMENT SERVICE.

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

The Bureau registers technical men, or those qualified for supervisory positions, and vacancies of like nature, only, as no attempt will be made to supply common mine and mill labor.

A list of current applications for positions and 'positions open' is carried in each issue. Notices are designated by a key number, and the name and address corresponding to any number will be supplied upon request, without delay or charge of any kind. If desired, recommendations may be filed with an application, but copies only should be sent to the Bureau, to avoid possible loss. Registration cards for the use of both prospective employers and employees may be obtained at any office of the Bureau upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded.

POSITIONS WANTED.

- 51-5 Mine Accountant. Twelve years experience time-keeping, cost sheet work, etc., for large copper mining company, coupled with knowledge of actual mine work. Age 54. Married. References. Salary wanted, \$150 to start.



PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU.

During the past forty-four years, in carrying out the provisions of the organic act creating the California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the state, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the Bureau's offices in the Ferry Building, San Francisco; New Orpheum Building, Los Angeles; Chamber of Commerce Building, Sacramento; Santa Maria; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states, and foreign countries.

A catalog of all publications of the Bureau, from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the offices of the State Mining Bureau and enclosing the requisite amount in the case of publications that have a list price. The Bureau is authorized to receive only coin. stamps or money orders, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the State Mining Bureau.

REPORTS.

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks-----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks-----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks-----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. -----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	----

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.-----	\$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford-----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford-----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper-----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper-----	.50
Mines and Mineral Resources, Del Norte, Humboldt, and Mendocino Counties, 59 pp., paper-----	.25
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper-----	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper-----	.35
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper-----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou, and Trinity Counties, 974 pp., 275 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper-----	----
**Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter, and Tehama Counties, 91 pp., paper-----	----
Mines and Mineral Resources, El Dorado, Placer, Sacramento, and Yuba Counties, 198 pp., paper-----	.65
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties, 183 pp., paper-----	.65
Mines and Mineral Resources, Los Angeles, Orange, and Riverside Counties, 136 pp., paper-----	.50
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper-----	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report, Biennial Period 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper-----	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper-----	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper-----	.50
Seventeenth Report of the State Mineralogist, 1920, Mining in California during 1920, Fletcher Hamilton: 562 pp., 71 illustrations, cloth-----	1.75
Eighteenth Report of the State Mineralogist, 1922, Mining in California, Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.		Price
**January, **February, March, April, May, June, July, August, September, October, November, December, 1922-----	Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 -----	Free Free
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy-----	Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange counties-----	\$0.25 .25
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura counties-----	July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego counties -----	.25 .25
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara counties-----	Subscription, \$1.00 in advance (by calendar year, only).	.25
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz counties -----	April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial counties -----	.25 .25
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties--	October, 1926, Mines and Mineral Resources of El Dorado and Inyo counties	.25 .25
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island-----		.25
Chapters of State Oil and Gas Supervisor's Report: Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume) -----	Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	Free
**April, **May, June, **July, **August, **September, **October, November, **December, 1919 -----	January, February, March, April, **May, June, July, **August, September, October, November, December, 1920-----	Free Free
January, **February, **March, **April, May, June, **July, August, **September, **October, **November, **December, 1921-----	January, February, March, April, May, June, July, August, September, October, November, December, 1922-----	Free Free
January, February, March, April, May, June, July, August, September, October, November, December, 1923-----	January, February, March, April, May, June, July, August, September, October, November, December, 1924-----	Free Free
January, February, March, April, May, June, July, August, September, October, November, December, 1925-----	January, February, March, April, May, June, July, August, September, October, November, December, 1926-----	Free Free

BULLETINS.

Asterisks (**) indicate the publication is out of print.

**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations-----	
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations-----	
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps-----	

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.		Price
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)-----		----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations-----		----
Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston. 85 pp., 46 illustrations-----		\$0.50
**Bulletin No. 7. Mineral Production of California, by Counties for the year 1894, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 8. Mineral Production of California, by Counties for the year 1895, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations-----		----
**Bulletin No. 10. A bibliography Relating to the Geology, Palæontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.-----		----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations-----		----
**Bulletin No. 12. Mineral Production of California, by Counties for 1896, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 13. Mineral Production of California, by Counties for 1897, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 14. Mineral Production of California, by Counties for 1898, by Charles G. Yale-----		----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899-----		----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations-----		----
**Bulletin No. 17. Mineral Production of California, by Counties for 1899, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations-----		----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps-----		----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899-----		----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet-----		----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet-----		----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, and 9 maps-----		.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps-----		----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 26. Mineral Production of California for the past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet-----		----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps-----		----
**Bulletin No. 28. Mineral Production of California, for 1902, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet-----		----
**Bulletin No. 30. Bibliography Relating to the Geology, Palæontology, and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.-----		----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet-----		----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps-----		----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet-----	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California-----	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905, 120 pp., 66 illustrations, 3 maps-----	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations-----	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map-----	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet-----	----
**Bulletin No. 41. Mines and Minerals of California, for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps-----	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps-----	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.-----	----
Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.-----	\$0.30
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 48. Mineral Production of California for Twenty Years. 1906, by Charles G. Yale-----	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.-----	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman, 366 pp., 74 illustrations. (Revised edition.)-----	1.00
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker, 62 pp.-----	----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker. 78 pp.-----	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations and 10 maps-----	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 60. Mineral Production for 1909, County Maps and Mining Laws of California, by D. H. Walker. 94 pp.-----	----
**Bulletin No. 61. Mineral Production of California, by Counties for 1910, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker, 1910. Tabulated sheet-----	----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.		Price
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps-----		----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.---		----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.---		----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp. -----		----
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp. -----		----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.-----		----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]-----		----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.-----		----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp., 4 illustrations-----		----
Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.-----		\$0.25
Reconnaissance Geologic Map (of which, Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch = 12 miles. Mounted-----		2.50
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the fiscal year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations-----		----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations-----		Free
**Bulletin No. 75. United States and California Mining Laws, 1917. 115 pp., paper -----		----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring, 1918. 248 pp., 51 illustrations, 5 maps, paper-----		.50
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880-1917, by E. S. Boalich. 44 pp., paper-----		Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley, 1918. 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth-----		1.50
Bulletin No. 79. Magnesite in California, by Walter W. Bradley, 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth-----		1.00
Bulletin No. 80. Tungsten, Molybdenum and Vanadium in California. (In preparation.) -----		----
Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)--		----
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1916-1917, by R. P. McLaughlin, 1918. 412 pp., 31 illustrations. cloth-----		----
Bulletin No. 83. California Mineral Production for 1917, with County Maps, by Walter W. Bradley. 179 pp., paper-----		Free
**Bulletin No. 84. Third Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1917-1918, by R. P. McLaughlin, 1918. 617 pp., 28 illustrations, cloth-----		----
**Bulletin No. 85. Platinum and Allied Metals in California, by C. A. Logan, 1919. 10 photographs, 4 plates, 120 pp., paper-----		----
Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley, 1919. 212 pp., paper-----		Free
**Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello, 1920. 124 pp., paper-----		----
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley, 1920. 204 pp., paper-----		Free
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leek, 1921. 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth-----		----
Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley, 1921. 218 pp., paper-----		Free

BULLETINS—Continued.

	Price
Asterisks (**) indicate the publication is out of print.	
Bulletin No. 91. Minerals of California, by Arthur S. Eakle, 1923, 328 pp., cloth -----	\$1.00
Bulletin No. 92. Gold Placers of California, by Chas. S. Haley, 1923. 167 pp., 36 photographs and 7 plates (colored and line cuts, also geologic map), cloth -----	1.50
Extra copies of the Geologic Map (in 4 colors) -----	.50
Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley, 1923, 188 pp., paper -----	Free
Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley, 1924, 162 pp., paper -----	Free
Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin, 1925. 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth -----	2.00
Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley, 1925. 173 pp., paper -----	Free
Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley, 1926. 172 pp., paper -----	Free

PRELIMINARY REPORTS.

Asterisks (**) indicate the publication is out of print.

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin. 4 pp. -----	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp. -----	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp. -----	Free
Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper -----	Free
Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper --	Free
**Preliminary Report No. 6. A Review of Mining in California During 1919. Fletcher Hamilton, 1920. 43 pp. Paper -----	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper -----	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. Fletcher Hamilton, 1922. 68 pp. Paper -----	----

MISCELLANEOUS PUBLICATIONS.

Asterisks (**) indicate the publication is out of print.

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp. -----	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp. -----	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp. -----	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp. -----	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp. -----	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp. -----	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894 -----	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper -----	----

MISCELLANEOUS PUBLICATIONS—Continued.

	Page
Asterisks (**) indicate the publication is out of print.	
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper-----	Free
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 -----	Free

MAPS.

Register of Mines With Maps.

Asterisks (**) indicate out of print.

**Register of Mines, with Map, Amador County -----	----
**Register of Mines, with Map, Butte County -----	----
**Register of Mines, with Map, Calaveras County -----	----
**Register of Mines, with Map, El Dorado County-----	----
**Register of Mines, with Map, Inyo County -----	----
**Register of Mines, with Map, Kern County -----	----
**Register of Mines, with Map, Lake County -----	----
**Register of Mines, with Map, Mariposa County -----	----
**Register of Mines, with Map, Nevada County -----	----
**Register of Mines, with Map, Placer County -----	----
**Register of Mines, with Map, Plumas County -----	----
**Register of Mines, with Map, San Bernardino County -----	----
**Register of Mines, with Map, San Diego County-----	----
Register of Mines, with Map, Santa Barbara County (1906)-----	\$0.25
**Register of Mines, with Map, Shasta County -----	----
**Register of Mines, with Map, Sierra County -----	----
**Register of Mines, with Map, Siskiyou County -----	----
**Register of Mines, with Map, Trinity County -----	----
**Register of Mines, with Map, Tuolumne County -----	----
Register of Mines, with Map, Yuba County (1905)-----	.25
Register of Oil Wells, with Map, Los Angeles City (1906)-----	.35

OTHER MAPS.

Asterisks (**) indicate the publication is out of print.

**Map of California, Showing Mineral Deposits (50 x 60 in.)-----	----
**Map of Forest Reserves in California-----	----
**Mineral and Relief Map of California-----	----
**Map of El Dorado County, Showing Boundaries, National Forests-----	----
**Map of Madera County, Showing Boundaries, National Forests-----	----
**Map of Placer County, Showing Boundaries, National Forests-----	----
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**Map of Sierra County, Showing Boundaries, National Forests-----	----
**Map of Siskiyou County, Showing Boundaries, National Forests-----	----
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**Map of Mother Lode Region-----	----
**Map of Desert Region of Southern California-----	----
Map of Minaret District, Madera County-----	.20
Map of Copper Deposits in California-----	.05
**Map of Calaveras County -----	----
**Map of Plumas County -----	----
**Map of Trinity County -----	----
**Map of Tuolumne County-----	----
Geological Map of Inyo County. Scale 1 inch equals 4 miles-----	.60
Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin -----	.25
**Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted-----	----
Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92 (sold singly). In 4 colors -----	.50

OIL FIELD MAPS.

Price

These maps are revised from time to time as development work advances and ownerships change.

Map No. 1—Sargent, Santa Clara County-----	\$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos-----	.75
Map No. 3—Santa Maria, including Casmalia and Lompoc-----	.75
Map No. 4—Whittier-Fullerton, including Olinda, Brea Canyon, Puente Hills, East Coyote and Richfield-----	.75
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello -----	.75
Map No. 6—Salt Lake, Los Angeles County-----	.75
Map No. 7—Sunset and San Emido and Kern County-----	.75
Map No. 8—South Midway and Buena Vista Hills, Kern County-----	.75
Map No. 9—North Midway and McKittrick, Kern County-----	.75
Map No. 10—Belridge and McKittrick, Kern County-----	.75
Map No. 11—Lost Hills and North Belridge, Kern County-----	.75
Map No. 12—Devils Den, Kern County-----	.75
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Map No. 16—Ventura-Ojai, Ventura County-----	.75
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County-----	.75
Map No. 18—Piru-Simi-Newhall Oil Fields-----	.75
Map No. 19—Arroyo Grande, San Luis Obispo County-----	.75
Map No. 20—Long Beach Oil Field-----	1.25
Map No. 21—Portion of District 4, Showing Boundaries of Oil Fields, Kern and Kings counties-----	.75
Map No. 22—Portion of District 3, Showing Oil Fields, Santa Barbara County -----	.75
Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County -----	.75
Map No. 24—Portion of District 1, Showing Boundaries of Oil Fields, Los Angeles and Orange counties-----	.75
Map No. 26—Huntington Beach Oil Field-----	.75
Map No. 27—Santa Fe Springs Oil Field-----	.75
Map No. 28—Torrance, Los Angeles County-----	.75
Map No. 29—Dominguez, Los Angeles County-----	.75
Map No. 30—Rosecrans, Los Angeles County-----	.75
Map No. 31—Inglewood, Los Angeles County-----	.75
Map No. 32—Seal Beach, Los Angeles and Orange Counties-----	.75

DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

THE STATE MINING BUREAU
CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE
MINERAL RESOURCES OF CALI-
FORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the state, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the State Mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily.

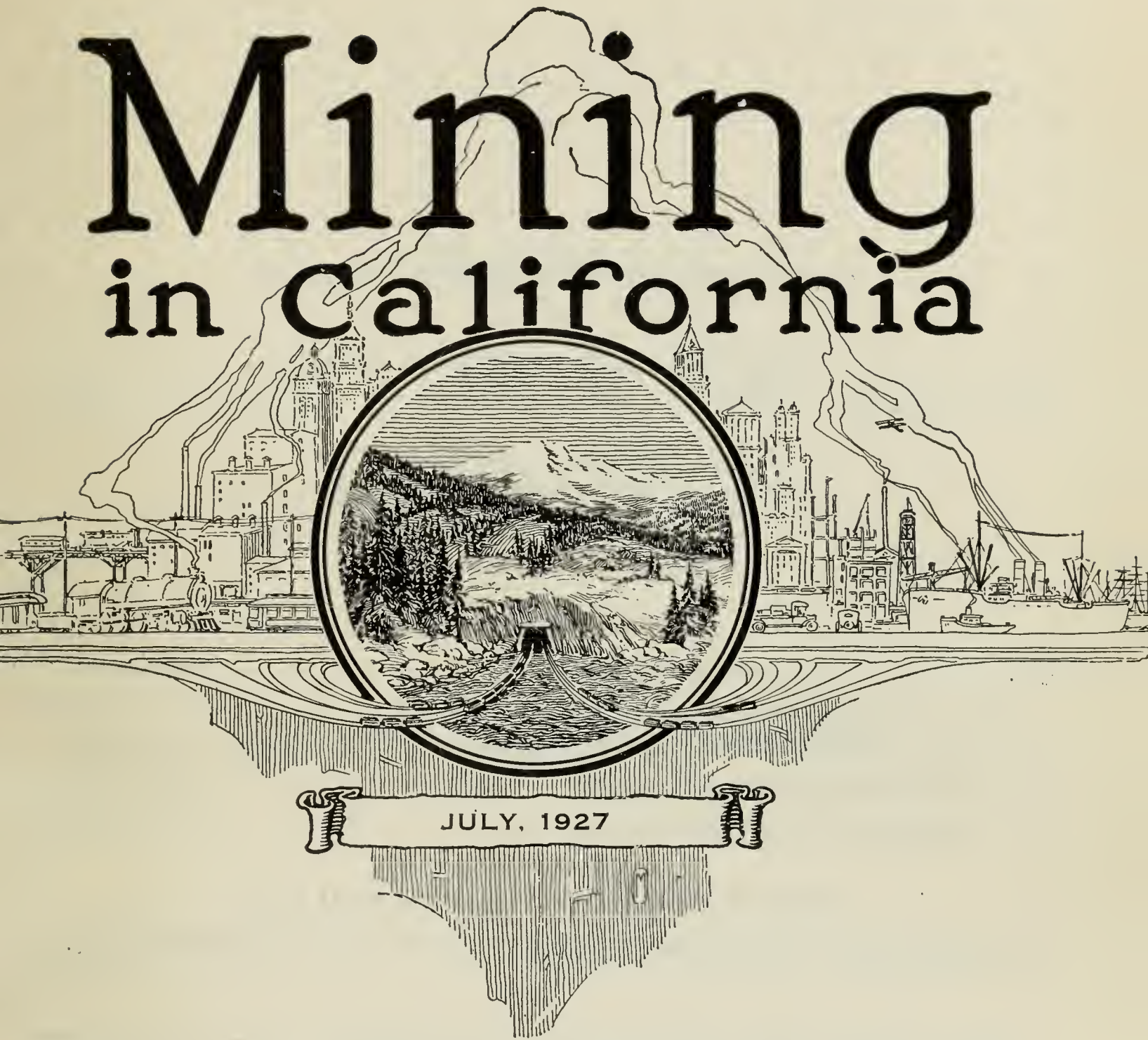
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Branch Offices: New Orpheum Building, Los Angeles; Chamber of Commerce Building (mail address, P. O. Box 1208), Sacramento; Bank of Italy Building, Bakersfield; Taft, Coalinga, Santa Maria, and Santa Paula.

Mining in California



PUBLISHED QUARTERLY
CALIFORNIA STATE
MINING BUREAU

FERRY BUILDING
SAN FRANCISCO

CALIFORNIA STATE MINING BUREAU

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NOTE.—A detailed report of the activities of the Department of Petroleum and Gas is issued monthly by the State Mining Bureau, entitled 'Summary of Operations, California Oil Fields.'

CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT

State Mineralogist

Vol. 23

JULY, 1927

No. 3

CHAPTER OF

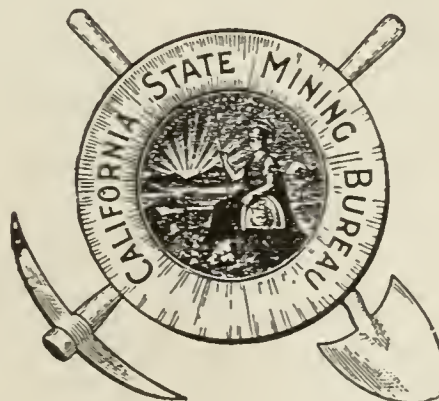
REPORT XXIII OF THE STATE
MINERALOGIST

COVERING

MINING IN CALIFORNIA

AND THE

ACTIVITIES OF THE STATE MINING BUREAU



CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO, 1927

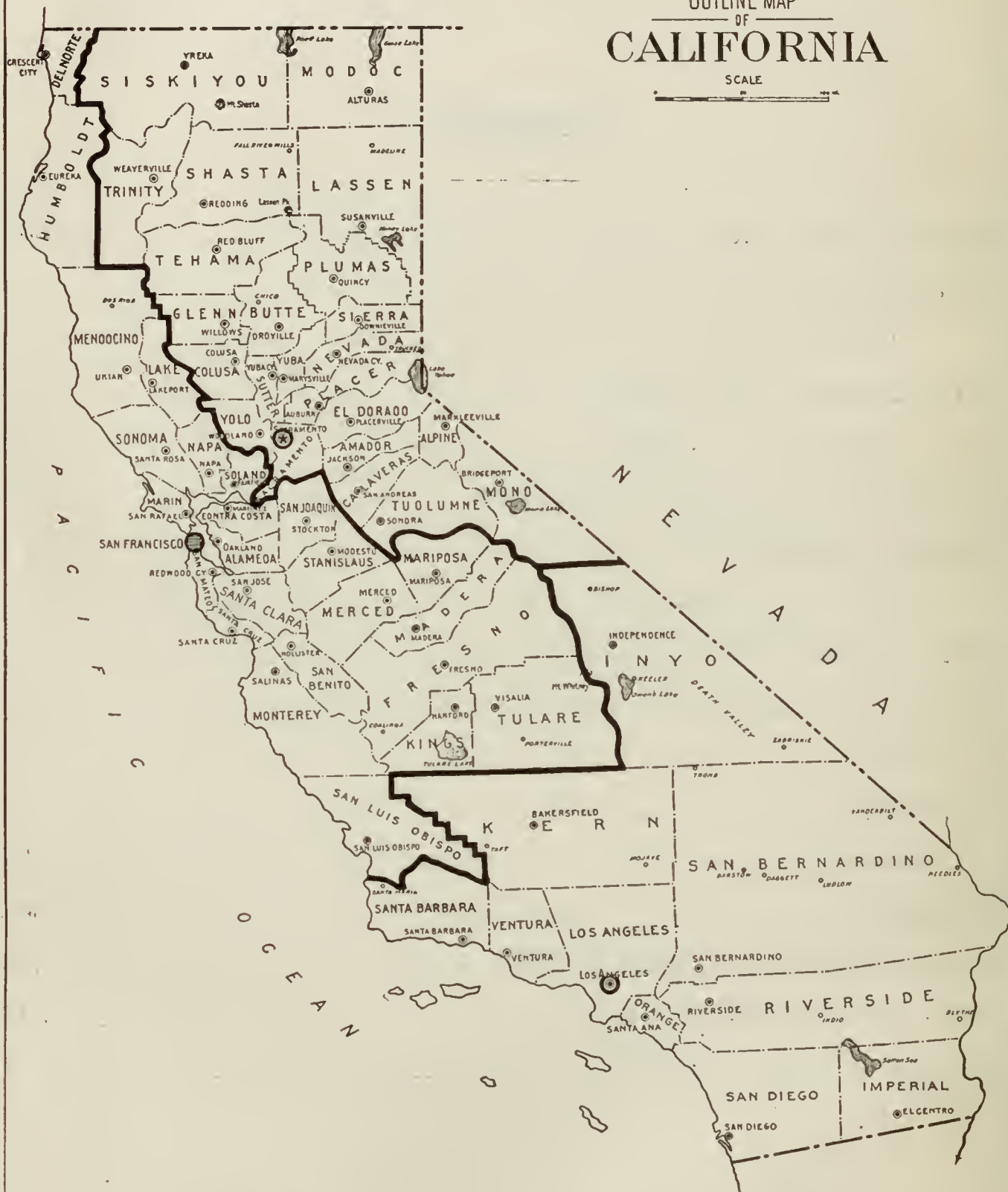
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CALIFORNIA STATE MINING BUREAU
LLOYD L. ROOT
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE



- LEGEND -

- Mining Division Boundaries
- Mining Division Offices.

MEXICO

PREFACE.

The State Mining Bureau is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

The weak point in work of this character has been that the results of field investigations were so long in preparation that they had lost much of their usefulness by the time they finally appeared in print.

As a progressive step in advancing the interests of the mineral industry, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923.

Owing to a lack of funds for printing, this was changed to quarterly publication beginning in September, 1923.

For the same reason, beginning with the January, 1924, issue, it has been necessary to charge a subscription price of \$1 per calendar year, payable in advance; single copies, 25 cents apiece. 'Mining in California' will continue to be sent without charge to our exchange list, including schools and public libraries, as are also other publications of the State Mining Bureau.

Pages are numbered consecutively throughout the year and an index to the complete reports is included annually in the closing number.

Such a publication admits of several improvements over the old method of procedure. Each issue contains a report of the current development and mining activities of the state, prepared by the district mining engineers. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance also are reported.

While current activities of all descriptions will be covered in these chapters, the Bureau will not discontinue its practice of issuing from time to time technical reports on special subjects. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters will be subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Mining Bureau is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

DISTRICT REPORTS OF MINING ENGINEERS.

In 1919-1920 the Mining Department was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the Bureau into closer personal contact with operators, and it has many advantages over former methods of conducting field work. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The boundaries of each district were adjusted and the counties now included in each of the three divisions, and the locations of the branch offices, are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the district engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the state's oil fields is included under this heading.

New County Reports.

The series of separate reports on the mines and mineral resources of the different counties, that together comprise the State Mineralogist's Reports XIV to XVII, inclusive, in the case of many of the counties have become exhausted. Those still in stock are in need of revision. It was deemed advisable, therefore, beginning with the January, 1925, issue of 'Mining in California,' to make the district engineers' reports in the form of a complete general report on the mines and mineral resources in one or more of the counties in each district.

This program will be followed as near as possible in succeeding numbers of the quarterly until each county in the state has been covered.

SACRAMENTO FIELD DIVISION.

C. A. LOGAN, Mining Engineer.

PLACER COUNTY.

Geography.

Placer County extends from the Sacramento Valley on the west for a distance of 80 miles to the Nevada state line on the eastern slope of the Sierra Nevada, including the larger part of Lake Tahoe. The total area is 1395 square miles. The elevation increases gradually from near sea level on the west to mountain peaks 8000 to 9000 feet high along the summit of the range on the east, then descends to 6225 feet along Lake Tahoe. There is a corresponding variation in climatic conditions. The western part of the county below an elevation of 2500 feet supports most of its industries and nearly all of the population of about 20,000. In this region snow seldom falls below 2000 feet elevation and never

lies on the ground below that elevation. The county seat, Auburn, is at an elevation of 1360 feet, and the district from there westward through Newcastle, Penryn, Loomis and Rocklin is the most important deciduous fruit producing area in the state, Newcastle being the leading shipping point. The soil is mainly decomposed granite and granodiorite on the west and amphibolite schist and diabase near Auburn and to the east, until the granodiorite of the high mountains is reached.

The Ogden route of the Southern Pacific system traverses the county from the Sacramento line to the summit of the Sierra Nevada, passing through the principal towns, and the Oregon branch of the same railroad, leaving the main line at Roseville, passes northward through Lincoln, serving the farming and clay-working industries there. Two state highways run about parallel to the two lines of railroad, one eastward from Sacramento over the mountains, and the other northward from Roseville along the east side of Sacramento Valley. A third state highway runs north from Auburn to Grass Valley and Nevada City, in Nevada County.

Taking its name from the Spanish, because of the richness of its surface gold placers, the county showed a great diversity of mineral resources at an early date, and was distinctly a mining county until about 1890, when fruit raising began on a large scale for eastern shipment. Lumbering and the summer grazing of cattle in the higher mountains have been less important industries.

Mineral Resources.

Gold has been the principal mineral product, but there is no exact record of the output prior to 1880 except for some individual mines. An estimated total of \$70,000,000 to date is probably reasonable; of this total, about \$35,500,000 is known to have been produced since 1880, when the keeping of production statistics began. Not to exceed \$5,000,000 of the total came from quartz mines, so it is seen that the county was aptly named.

Granite production began at Penryn and Rocklin as soon as the Central Pacific Railroad reached these points (about 1864) to furnish an outlet. Several hundred men were employed at the quarries at these two towns until about 1890, when labor strikes wrecked the industry there. Small operations continue at Rocklin.

The clay working business began at Lincoln 51 years ago and has grown steadily until at present several hundred men are employed, and it is the most important branch of the mineral industry in the county.

A fine grade of charcoal pig iron was produced from local ore treated in blast furnaces near Clipper Gap during the eighties. Copper has been produced from mines of the foothill copper belt along the western side of the county. Chromite was mined and shipped between 1916 and 1920, principally from the Forest Hill divide. Small tonnages of asbestos, manganese ore, magnesite, mineral paint, soapstone and quartz, and considerable limestone and miscellaneous stone, have been shipped. Platinum group metals have been recovered as a by-product in placer gold mines, especially in the present channel of American River. Low-grade lignite occurs near Lincoln, associated with the Tertiary clay beds, and was mined over 50 years ago for use in making gas in Sacramento.

Year	Gold, value	Silver, value	Copper		Brick		Pottery clay†		Lime and limestone		Miscel- laneous stone ¹ , value	Miscellaneous and unapportioned		
			Pounds	Value	M.	Value	Tons	Value		Amount		Amount	Value	Substance
1880	\$838,133	\$640												
1881	850,000	6,500												
1882	800,000													
1883	810,000													
1884	887,320	5												
1885	906,301													
1886	1,071,663	1,397												
1887	855,510	556												
1888	850,000	1,000												
1889	1,245,491	1,975												
1890	1,003,602	1,045												
1891	998,495	5,921												
1892	1,159,080	2,120												
1893	1,351,250	616												
1894	1,851,215	664					22,000	\$27,500			\$67,200			
1895	1,599,635	5,273					15,000	15,000			56,620	25 tons	\$1,000	Asbestos.
1896	1,674,844	6,690					10,000	10,000			44,216			
1897	1,524,941	6,784					7,500	7,500			39,412			
1898	1,488,022	5,670					12,000	12,000			29,333			
1899	1,100,081	1,206					15,000	15,000			61,525			
1900	986,155	12,058					15,000	15,000			115,669			
1901	900,745	4,828	11,200	\$1,764			15,000	15,000			102,847			
1902	843,366	3,341	3,200	368			15,000	15,000			156,402			
1903	570,571	1,116	4,000	520			15,000	15,000	{	\$1,500 \$4,000	\$9,000 4,000			Platinum. Quartz.
1904	778,355	9,320	600,000	76,500			16,100	16,100			123,448			Platinum
1905	597,793	8,041	367,250	57,291			20,000	10,000		\$15,533	8,737			Platinum.
1906	4	4	200,000	38,600			20,000	15,000		\$11,699	11,950			Platinum.
1907	482,772	3,338					20,000	20,000				2 ozs.		Asbestos.
1908	358,096	2,194			13,000	\$46,300	13,000	11,500		\$38,869	79,768	50 tons	2,500	Asbestos.
1909	281,372	1,492			2,083	52,300	45,300	35,250		\$24,322	25,864			Unapportioned, 1901-1902.
1910	257,191	1,157			600	23,438	44,000	27,000		\$10,000	12,100	60 tons	6,000	Asbestos.
1911	251,298	2,585	118,624	14,828	700	18,000	43,120	29,200				125 tons	500	Asbestos.
1912	367,383	4,791	78,170	12,898	900	21,250	56,000	41,300		\$222,595	200,000	300 tons	3,300	Magnesite.
1913	220,785	2,972	429	67	1,900	40,000	63,600	47,200				90 tons	584	Mineral paint.
1914	600,000	4,500	453	60	2,000	40,000	63,700	49,000		\$202,575	202,575	50 tons	500	Magnesite.
1915	414,319	24,543	4		2,000	40,000	49,126	37,536		\$1,236	2,432	1,000 tons	2,000	Glass sand.
1916	428,400	24,928	1,437,441	353,610	2,540	79,000	29,018	36,230				805 lbs.	35	Lead.
1917	538,686	13,885	710,601	193,994	4		44,097	44,097				2,000 tons	4,000	Quartz.
1918	230,190	22,432	837,527	206,869	and tile	81,408	29,348	29,348				385 lbs.	15	Lead.
1919	170,600	3,141			4							711 lbs.	33	Lead.
1920	151,088	2,178												Asbestos and copper.
1921	132,468	1,068										744 tons	346,810	Chromite.
1922	119,673	952												Granite.
1923	75,732	297										4,287 tons	105,384	Lead, limestone, magnesite.
1924	108,757	534												Chromite.
1925	121,785	620												Granite.
1926	82,921	346												Asbestos, brick, platinum, tile, gems, magnesite.
Totals	\$32,936,093	\$204,689	4,368,895	\$957,369		\$1,339,550	1,307,102	\$1,455,016		\$569,566	\$3,329,383	4,963 tons	276,765	Chromite.
												1,018 tons	24,000	Granite.
														Manganese and silica.
														Chromite.
														Clay and clay products.
														Granite.
												300 tons	1,055	Other minerals.
														Chromite.
														Granite.
														Chromite, mineral paint, silica.
														Granite.
												2,000 tons	5,500	Silica.
														Other minerals ⁵ .
														Granite.
												3,656 tons	10,040	Silica (quartz).
														Other minerals. ⁶
														Granite.
														Other minerals. ⁷
														Granite.
														Other minerals. ⁸
												6092 cu. ft.	11,969	Granite.
													6,000	Other minerals.

¹ Includes granite (prior to 1916), crushed rock, rubble, rip-rap, paving blocks, sand, gravel.² Barrels of lime.³ Tons of limestone.⁴ See under 'Unapportioned.'⁵ Includes chromite, mineral paint, mineral water.⁶ Includes brick, building tile, chromite.⁷ Includes mineral paint, mineral water, silica (quartz).⁸ Includes chromite, copper, silica (quartz).

† Figures for value of clay are for crude clay only. The annual value of clay products is several times greater, but is omitted because there is only one factory. Production began in 1875.

Power and Water.

The quartz mining district near Ophir and Auburn, the foothill copper belt, the Lincoln clay pits and properties near the railroads have the advantage of electric power. Some mines along the Forest Hill divide had their own hydro-electric power plants, but most of them in this region and in the more remote mountainous districts must rely on gasoline engines. There are no streams of importance on the extensive lava plateaus under which the buried gravel channels occur. Drainage is confined to the forks of American River, which flow in canyons 1000 to 2500 feet below the tops of the ridges, and to steep tributaries which have likewise cut deep canyons far below the general level of the surface. Water rights for the most part have been appropriated by large companies, such as the Pacific Gas and Electric Company, which controls the distribution of electric power and water for irrigation, so far as developed, and at least two other large power projects are now being planned to use water from the American River.

Timber.

There is an abundant timber supply in the eastern part of the county, particularly along the Forest Hill and Iowa Hill divides and in the higher mountainous country extending from Forest Hill east and northeast to Lake Tahoe. This country has no railroad facilities and the only timber cut in most of the area has been that used for mining purposes. The entire section beginning a few miles east of Colfax, thence east and north to the county line, and comprising much more than half of the county, is within Tahoe National Forest. Forest fires along the flanks of the Forest Hill divide have destroyed considerable timber in recent years.

Transportation.

Besides the two lines of railroad mentioned, and the state highway system, there is a good system of county roads. The mines of the Forest Hill, Iowa Hill, Duncan Canyon and Last Chance districts are reached by roads from Colfax and Auburn, the last two named being between 50 and 60 miles from the county seat, and not accessible by auto after the first heavy snow.

ASBESTOS.

Both chrysotile and slip fiber amphibole asbestos occur in the county. None of the prospects are being worked at present. Both varieties occur in serpentine or along its contact with other rocks.

Blue Wing and Dewey Claims are in Sec. 28 and Sec. 33, respectively, in T. 15 N., R. 10 E., one-fourth mile east of Iowa Hill. They contain a ledge of white, slip-fiber tremolite asbestos, which shows in the bed-rock of the old hydraulic mine workings. It is at the contact of serpentine and the Cape Horn slate, and is reported to be from six to fifteen feet wide. The same ledge occurs on the *Washington* and *Clear Fiber* claims and is said to have been found in the old *Morning Star* drift mine. According to Waring, fibers eight inches long were of good quality.

Bibl: Cal. State Min. Bur. R. XV, pp. 321-322.

Driscoll & Michelson claims are in Sec. 1, T. 15 N., R. 10 E., a mile and a half southeast of Towle in the steep canyon of North Fork of American River. Only a meager prospect of slip-fiber asbestos in serpentine was observed on these claims.

Morgan Asbestos claims are a short distance east of the Driscoll & Michelson claims in the canyon of American River, a mile and a half southeast of Towle. These claims have produced some good quality, long-fiber asbestos, silky in texture and strong. Seventy tons are reported to have been shipped, but no work has been done lately.

Dan Sullivan, Alta, and associates have found a prospect of short cross-fiber chrysotile asbestos in serpentine about four miles north of Towle and on the south side of Bear River. Practically no work has been done on it, and as the surface is covered by loose rock, the extent of the deposit is unknown. The percentage of fiber in samples is high.

Wolf & Levy claims adjoin the Driscoll & Michelson claims and show similar meager prospects.

Prospects of chrysotile asbestos occur southwest of Cisco in the vicinity of Monumental Hill.

CHROMITE.

Placer County was an important producer of chromite during the World War, but in recent years only a small amount of high-grade ore has been marketed from a single property, operated by *Dan Sullivan*, Alta, close by the railroad near Gorge. The most productive district was that near the old Sugar Pine Mill on the divide east of Forest Hill and formerly the Damascus Mining District.

The table below gives the location of most of the properties active between 1917-1919, but since idle, with the one exception noted above. They were described in our Bulletin 76.

Table of Chromite Properties in Placer County.

Name	Location	Distance from R. R. point
Bunker -----	Sec. 21, T. 14 N., R. 11 E.---	21 miles to Colfax
DeKruse -----	S $\frac{1}{2}$ Sec. 30, T. 15 N., R. 11 E.	12 miles to Colfax*
Fiddlers Green -----	NE $\frac{1}{4}$ Sec. 29, T. 13 N., R. 9 E.	14 miles to Auburn
Garrison -----	1 mile SE. of Foresthill-----	16 miles to Colfax
Gas Canyon -----	Sec. 13, T. 13 N., R. 9 E.---	13 miles to Auburn
Green -----	SE $\frac{1}{4}$ Sec. 12, T. 13 N., R. 9 E.	13 miles to Auburn
Linder & Hodges-----	Sec. 25, T. 16 N., R. 10 E.---	2 miles to Alta
I. H. Parker-----	6 miles NE. of Auburn-----	6 miles to Auburn
Scheirmeier -----	At Michigan Bluff-----	20 miles to Colfax
Sugar Pine -----	Secs. 29, 31, T. 15 N., R. 11 E.	14 miles to Colfax*
Sullivan -----	NE $\frac{1}{4}$ Sec. 19, T. 16 N., R. 11 E.	Adjacent to R. R. track ; Gorge
Turner & Geisendorfer--	NE $\frac{1}{4}$ Sec. 30, T. 15 N., R. 11 E.	14 miles to Colfax*
Williamson & Beck-----	Secs. 19, 30, T. 15 N., R. 11 E.	13 miles to Colfax*

*These distances are by way of new Iowa Hill-Colfax road, now being built.

CLAY.

The clay industry is the most important branch of mining in Placer County, employing at present about 550 men at and near Lincoln, where all the work is carried on. The total annual production of crude clay is between 125,000 and 150,000 tons. Operations began there in 1875. Deposits of Ione age, which furnish the clay, occur at and near Lincoln, between Lincoln and Rocklin, and at Rocklin, but only those

first named have been developed. Taking their geologic name from the town in Amador County where similar beds exist, the Placer County deposits differ from those near Ione in some respects. They contain in places less silica sand, more alumina, and are more plastic, and some users mix the two in order to obtain the results desired.

After the clay was deposited, the stream channels and side valleys leading down from the foothills of the Sierra Nevada were filled by deposits of andesite boulders and mud. Subsequent erosion has removed the higher, unprotected land, leaving the best of the clay under the covering of andesite. There is an overburden of 12 to 22 feet, including 8 to 12 feet of the breccia and the balance impure sand and clay. Below this occur successive beds of different colored clay, including white, red, yellow and blue. On one property, lignite coal beds are known to lie at depths of 46 to 70 feet below the surface, and black clay, probably colored by lignitic material, was encountered elsewhere.

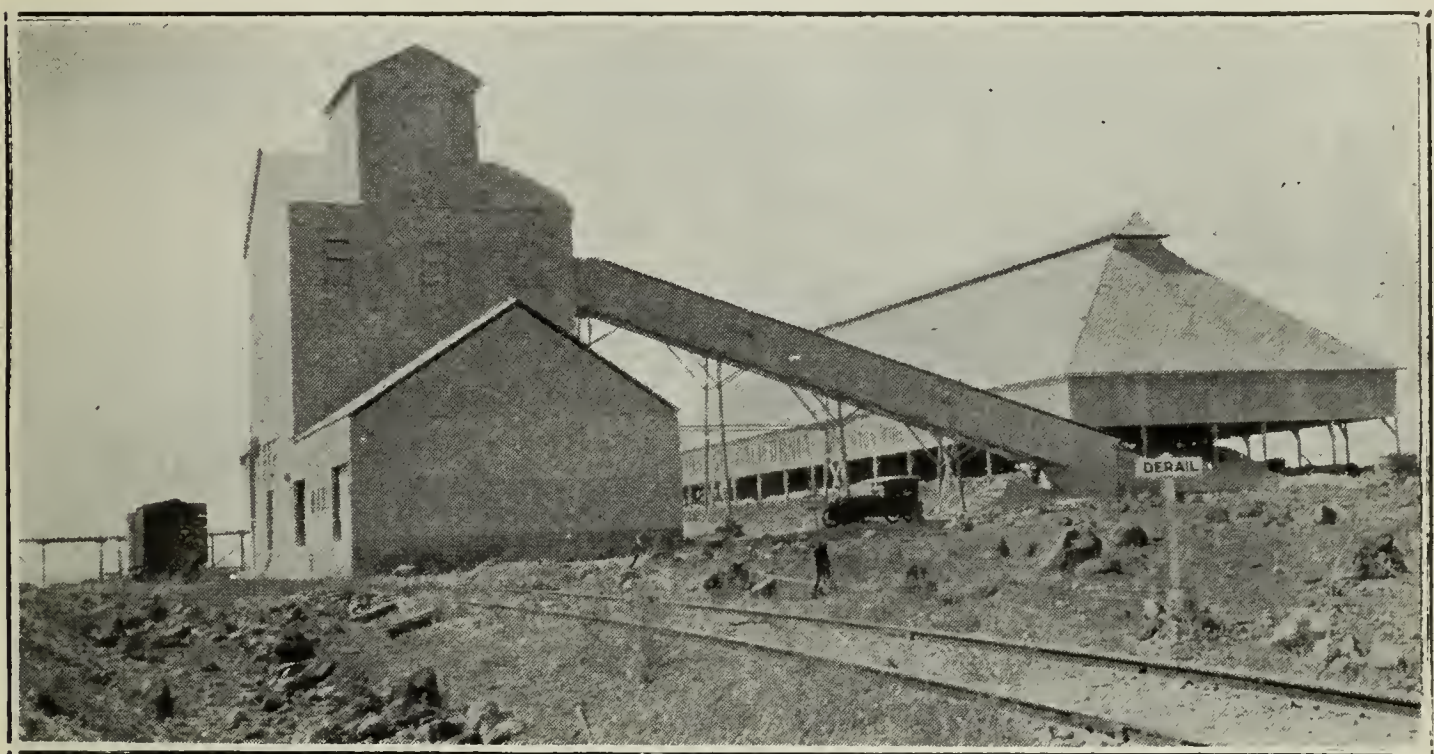


PHOTO No. 1.

Clay storage building and grinding plant of Clay Corporation of California near Lincoln.

Clay Corporation of California is a subsidiary of Stockton Fire Brick Company, which has a plant at Stockton and an office in the Rialto Building, San Francisco. O. M. Tupper is superintendent at the Lincoln property.

This property, two miles by road northwest of Lincoln, near the railroad, was opened to insure a steady supply of clay of uniformly high quality. There are more than 1,000,000 tons of clay available, according to preliminary estimates, in the 160 acres of clay land.

The overburden of andesite breccia and waste sand and clay is stripped with a P. & H. $\frac{3}{4}$ -cubic yard gasoline steam shovel and dumped just beyond the pit on land not considered as carrying enough clay to mine. A Plymouth 8-ton gasoline locomotive and nine rocker dump cars are used for waste and clay transportation. After enough ground is stripped for a season's run, clay is mined with the shovel, and hauled in trains of six cars to the storage building. So far a depth of 23 to 25 feet has been mined, including 15 feet of refractory

white and light-colored clay. This is underlain, in order, by 8 to 10 feet of red or pink clay, 12 feet of yellow clay, 20 feet of white and yellow mixed, and an indefinite depth, possibly 60 feet, of a good quality blue clay. Work is not planned below the red clay. From the rail trestle, clay is dumped to a 21- by 42-inch single roll crusher, operated by 40-h.p. electric motor, which crushes to 3-inch size, and from this the clay passes to a belt conveyor 366 feet long which elevates it to the top of the storage building, in which it is distributed uniformly, and is air dried. The storage building, 300 feet long by 70 feet wide, has a storage capacity of 15,000 tons. There is a concrete tunnel under it, fitted with gates and a belt conveyor, onto which clay is drawn for conveying to the grinding plant. This conveyor delivers to a second one, having an inclined belt which transports clay to the three storage bins above the grinding unit.



PHOTO No. 2.

Clay pit recently opened by Clay Corporation of California near Lincoln.

Clay is ground in a 5-roller Raymond mill giving a product of which 98% passes 100-mesh. A blower raises ground clay through a long pipe to the top of the mill building, from which it is distributed to three 50-ton storage bins. These are fitted with spouts for filling paper bags in which shipment is made.

The maximum mining capacity is estimated to be over 500 tons per 8-hour shift and the mill capacity up to about 50 tons a shift. The large storage capacity had to be provided to permit drying and because the pit is only worked in the dry season, six to seven months of the year. The plant is supplied with spur tracks from the Southern Pacific's Oregon line, 1600 feet distant. Clay is supplied to customers as well as for the company's own use. The storage and grinding plants are operated by electricity entirely. A detailed description of the enterprise by C. N. Schuette* was published in *Engineering and Mining Journal*-

*Mining Engineer, San Francisco, Calif.

Press, June 12, 1926. The plant was completed and began production late in 1925.

James Gavin, Forest Hill, has submitted for analysis at the city filtration plant, Sacramento, samples of decomposed rock, apparently originally a shale, reported to be from the bedrock of a gravel mine near Forest Hill. Partial analysis of two samples showed 36.72% Al_2O_3 and FeO in one case, and 48.87% Al_2O_3 and FeO in the other, with only a small amount of iron in the latter. The remaining parts of both samples were insoluble, and probably were chiefly silica. The deposit is 18 or 19 miles by road from Colfax, the nearest railroad station.

Gladding, McBean and Company operate at Lincoln the largest pottery in northern California. This plant was established in 1875 with one kiln, using wood fuel. Only recently the sons of the founders have turned over their official duties to others, the firm name having been bestowed upon a great consolidation of western clay products establishments (including manufacturing plants at Lincoln, Glendale, Los Angeles, Santa Monica, and Alberhill, as well as three plants in the state of Washington, one in Oregon and 21 separate clay mines and parcels of clay land). At Lincoln the company has about 500 acres of land, employs 500 men and produces annually about 50,000 tons of clay products. Charles Gladding is superintendent of the Lincoln plant.

The clay beds are covered by 6 to 12 feet of andesite breccia, containing some large, angular blocks. The main pit has been worked in five different benches. Sand and fine gravel, in places as much as 15 feet thick, furnished some red-burning clay. This lies above the fire-clay beds. Three benches in the clay are each about 15 feet high. Stripping and mining is done with steam shovels. Clay is hauled in side-dump cars to a storage shed 450 feet long by 75 feet wide. The following are analyses of the clay, furnished by the company:

	Fire clay	Red clay
Silica -----	50.38	56.47
Alumina -----	32.11	21.90
Ferric oxide -----	2.99	7.70
Titanium -----	.38	----
Manganese -----	.56	----
Calcium -----	1.15	1.15
Magnesium -----	1.07	1.26
Alkalies -----	----	0.27
Ignition loss -----	11.29	11.25
Moisture -----	----	----
Total -----	99.93	100.00

Color: Buff and red burning.

Shrinkage: Averages about 15%.

Fusibility: Fire clay, 3286° F.. Red clay, cone 10, 2426° F.

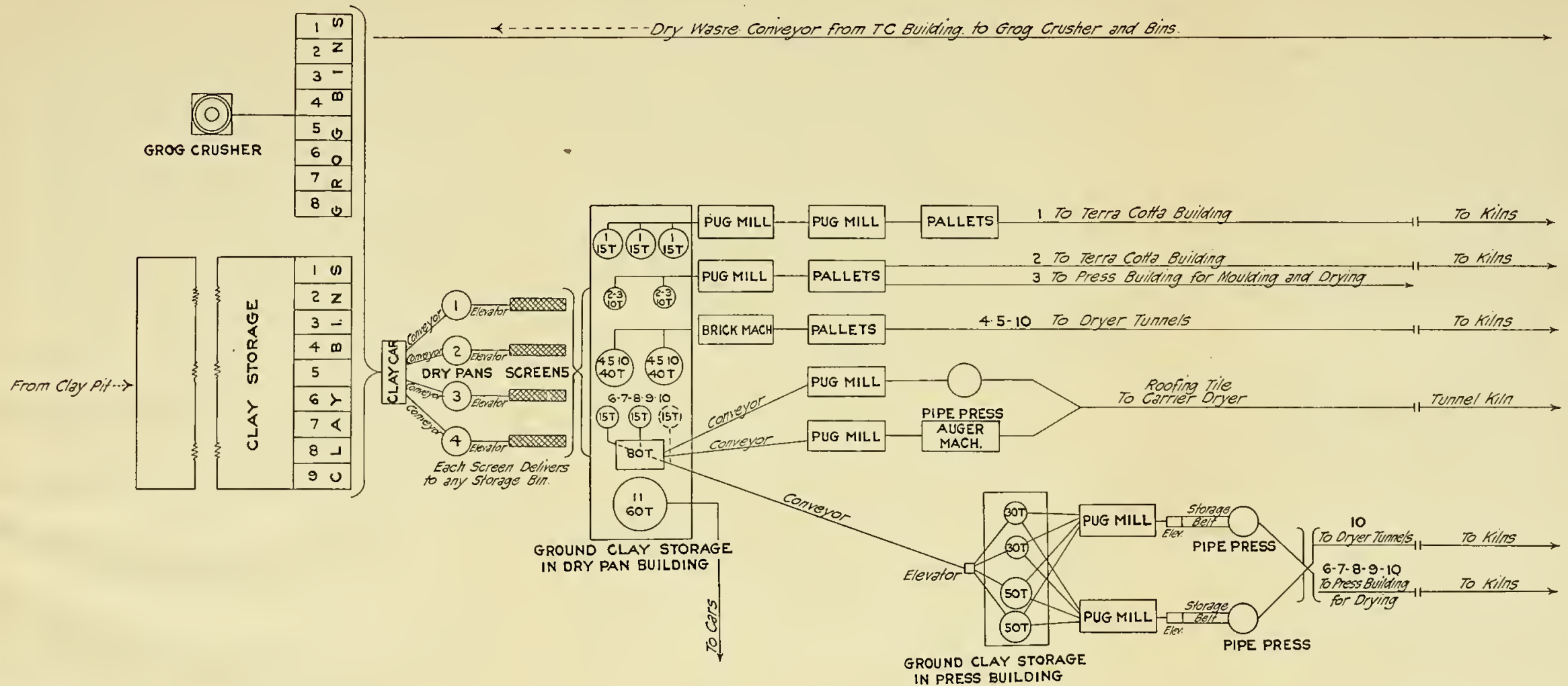
Absorption: 3% to 10%.

The process of grinding, screening and preparing the clay in the various shapes for the kilns is indicated on the accompanying flow sheet. A feature of interest in the grinding process is the automatic control of the feed to one of the dry pans. The conveyor feeding this dry pan is operated by a small electric motor, connected to the large motor driving the dry pan. When the large motor is under full load, with the dry pan working at capacity, the motor uses so much electricity that



PHOTO NO. 3.

Plant of Gladding, McBean and Company at Lincoln.



GROG BINS		
Reference Numbers	KIND OF GROG	Bin Capacity Tons
1	Sewer Pipe	30
2	Chimney Pipe	30
3	Terra Cotta	30
4	Quartz	30
5	Fire Tile	30
6	Creek Sand	30
7	Dry Waste from TC Bldg	30
8	Conduit Pipe	30
Total		210

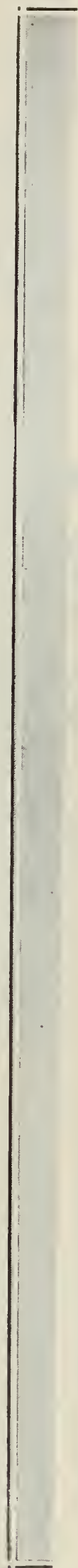
CLAY BINS		
Reference Numbers	KIND OF CLAY	Bin Capacity Tons
1	(Details not yet completed)	30
2		30
3		30
4		30
5		30
6		30
7		30
8		30
9		30
Total		270

GROUND CLAY STORAGE						
Reference Numbers	MANUFACTURED PRODUCT	Kinds of Clay	In Dry Pan Building		In Press Building	
			No. of Bins	Capacity Tons	No. of Bins	Capacity Tons
1	Terra Cotta	3	3	15	45	
2	Fire Tile	1	2	10	20	
3	Moulding Clay	1	2	40	80	
4	Face Brick	1	2	40	80	
5	Spanish Tile	1	2	40	80	
6	Roofing Tile	2	2	15	30	2
7	Sewer Pipe	1	2	15	30	2
8	Chimney Pipe	1	2	15	30	2
9	Fire Proofing	1	1	60	60	
10	Ground Clay	1	1	60	60	
11	Laundry Trays					
12	Garden Pottery					
13	Conduit Pipe					
14	Total			235	160	
* For Shipping Only			Total Storage 395 Tons			

GLADDING McBEAN AND CO. LINCOLN, CAL. FLOW SHEET

NOT TO SCALE.
Corrected to Aug. 15, 1927.

LELAND S. ROSENER
Consulting Engineer.
San Francisco, Cal.



the small one can not operate, stopping the conveyor until the dry pan can handle more clay. There are 22 round down-draft kilns, ten muffle kilns and a tunnel kiln in use, the latter being 364 feet long, holding 43 cars.

The terra cotta department is the most important, employing one-half or more of the total crew. The products of this department require a great deal of skilled hand labor as well as technical care. Architectural terra cotta made here has gone into the construction of many of the largest buildings put up in recent years on the Pacific coast. Granitex terra cotta, one of the later developments, resembles granite quite closely. The tempered clay-grog mix for these products is aged five or six days under damp burlap in cool rooms.

Other products include conduit pipe, sewer pipe, chimney pipe, fire brick, face brick, fire tile, garden pottery, roofing tile, building blocks, laundry trays, sinks and ornamental terra cotta. This plant was originally established to make sewer pipe, which still remains one of the principal products. The pipe is burned five days at a temperature of 1200° C.

The tunnel kiln was intended primarily to burn roofing tile, but has been tried successfully on sewer pipe and other products. This kiln is said to make a large fuel saving and to give improved working conditions. It has a capacity of 31 tons of roofing tile or 62 tons of brick in 24 hours.

Crude oil is used for fuel and electricity for power, including many storage battery trucks. Besides the local clay, they use loam from Oroville and clay and sand from Ione.

Lincoln Clay Products Company's clay land and plant are about two miles northwest of Lincoln, adjoining the state highway, and have a spur track connecting with the Southern Pacific Railroad. M. J. Dillman, president. Office, Lincoln, California.

The property was opened in 1908 and has been increasing its scale of operations steadily. There are 33 men employed at present, as compared with 12 in 1920.

The clay beds are covered by as much as 22 feet of overburden, which is stripped with a P. & H. gasoline shovel with $\frac{1}{2}$ -cubic yard dipper. The upper beds of clay, called No. 1 to No. 6, have a total thickness of 14 feet. These beds are white to light colored and clay from them burns lighter colored than that below, called the No. 7, or reddish clay, which is 12 feet thick; No. 8, a yellow clay, is 8 feet thick and below No. 7. Below No. 8, test pits have been sunk 12 to 14 feet in blue clay said to be of good quality. None of it has been marketed yet. In places on the property brown lignite was encountered at depths of 46 to 70 feet in drill holes.

Clay is mined by hand in benches and hauled from the pit in side dump cars by gasoline locomotives. Five of these locomotives, ranging from three to eight tons capacity, and 60 side-dumping ore cars are used. There are about three miles of narrow-gauge tracks in the pit. A hoist lifts the clay cars to the top of the storage building, where it is weighed and either dumped into gondola cars for immediate shipment or stored for air drying, as desired.

The widespread market supplied is shown by the fact that 46 customers are served. The principal products made from this clay are architectural terra cotta, face and common brick, tile, sewer pipe, building blocks, and firebrick. The Lincoln clay, on account of some variations

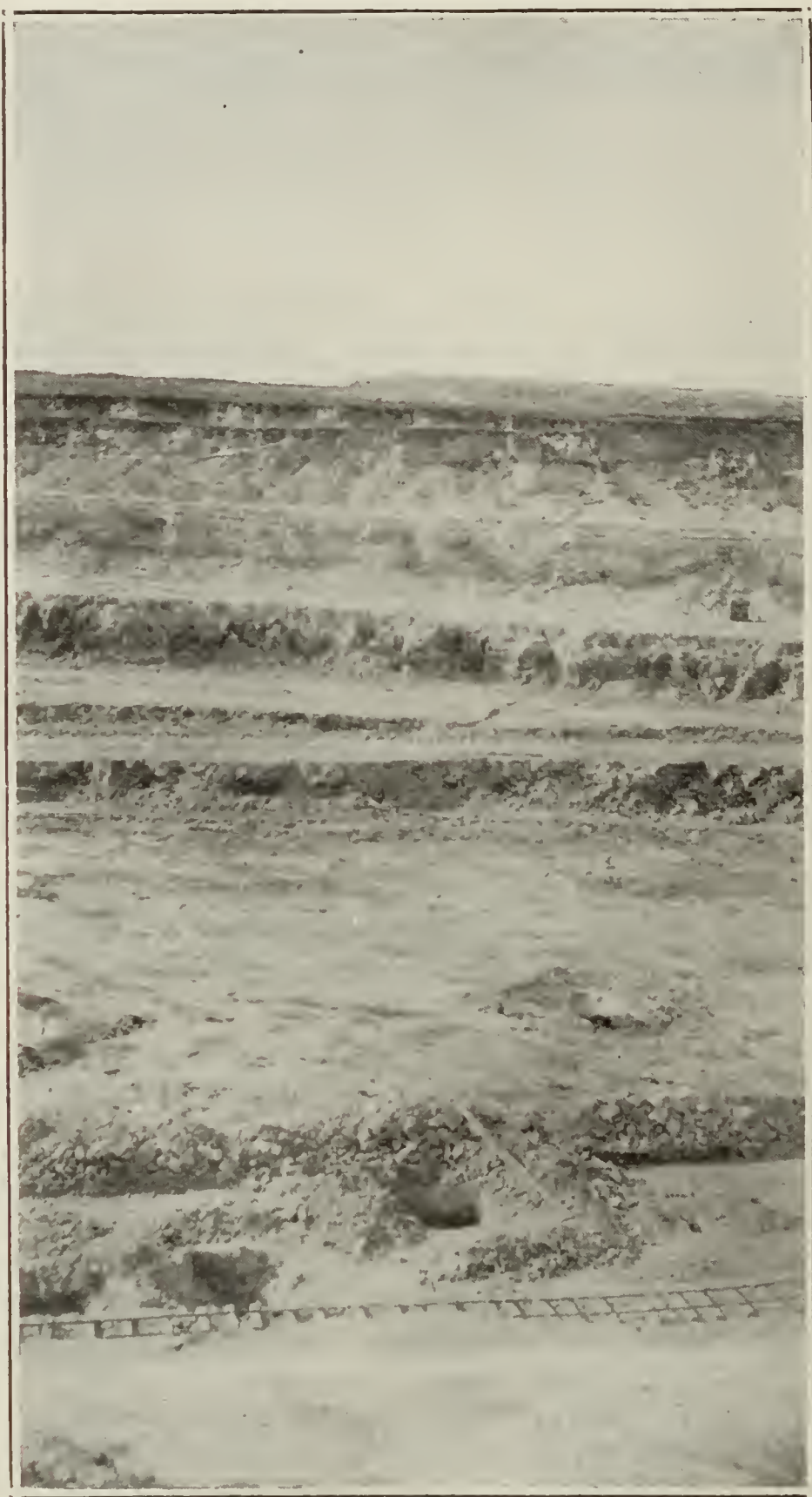


PHOTO No. 4.

A section of the clay pit of Lincoln Clay Products Company near Lincoln.

between it and the Ione clay, is often mixed with the latter to give desired shrinkage, freedom from spalling, or other qualities. There was formerly a small production of washed kaolin from an experimental plant at the property. This has been abandoned. Most of the clay is

shipped crude, either directly or after air drying, but a few carloads of ground clay are marketed monthly. The mill is a Williams Hammer mill, operated at 2200 r.p.m. by a 60-h.p. electric motor. The clay is ground through 16-mesh. A 24-inch Sturtevant fan exhausts ground clay into bins on the floor above the mill. This company works its pit throughout the year.

Undeveloped deposits of sandy clay occur from two miles east of Towle to a point west of Dutch Flat along the line of the Southern Pacific railroad. There are similar beds on *Towle Brothers'* property, near Towle station, and on the land of the Zeitler estate, about a mile and a half from Towle on the state highway. It is green when wet, but nearly white when dry. These deposits are rhyolitic sand and ash principally.

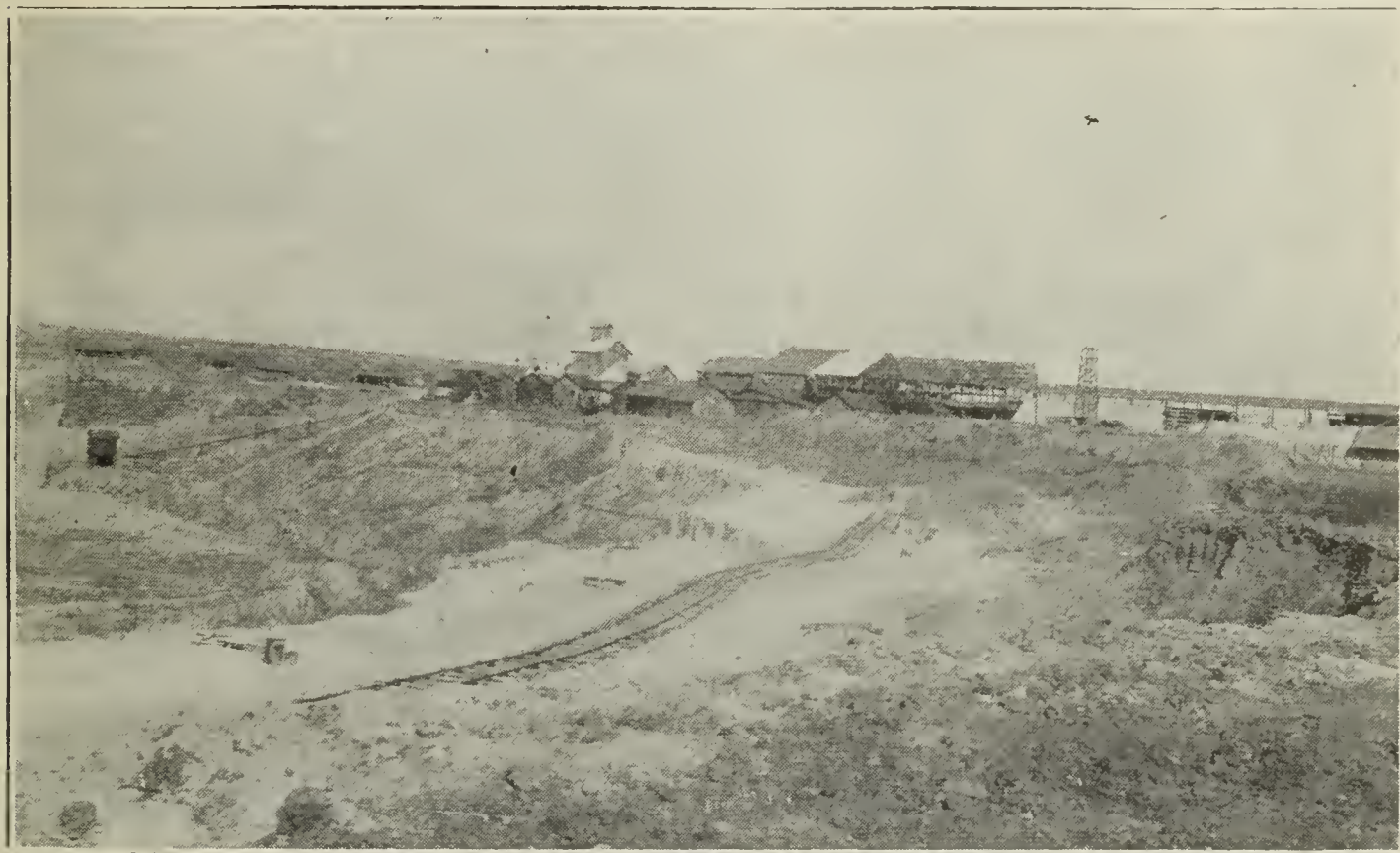


PHOTO NO. 5.

. Plant and a part of the clay pit, Lincoln Clay Products Company.

COAL (LIGNITE).

Lignite occurs at and near Lincoln, associated with the sand and clay of the Ione (Tertiary) formations. Fifty years ago or more small mining operations were carried on under the townsite and a mile northwest of the town. Caved ground indicates that coal was mined out under an area of several acres. Part of it, at least, was shipped to Sacramento and retorted to furnish gas.

The beds lie nearly flat, but with such a poor roof and floor that considerable timber was required. The mines were closed years ago because of increasing cost of operation and competition of other fuels.

Lincoln Clay Products Company owns land one mile northwest of Lincoln beside the state highway, where drilling has revealed the presence of lignite. The beds are reported to be 7 to 14 feet thick with a pink-clay roof and blue-clay floor. They lie at a depth of from 46 to 70 feet. The logs of the drill holes indicate a large unmined reserve of the

lignite. The mode of occurrence is similar to that near Ione, the deposits having been made in a chain of shallow marshy lakes or inlets along the shore line.

COPPER.

The recorded production of copper began in this county in 1901. From 1904 to 1906, inclusive, about 1,200,000 pounds were produced, after which a period of idleness ensued until 1911. There was a small output in 1911 and 1912, but it required the stimulus of high war-time prices to bring active operations which resulted in the production of about 3,000,000 pounds of copper between 1916 and 1918, inclusive. There has been no production since. The principal producers were the Dairy Farm Mine near Sheridan and the Valley View, northeast of Lincoln.

The small copper mines and prospects of the county are a part of the foothill copper belt, where carbonate and sulphide ores occur as a rule in amphibolite schist. The ores carried usually several dollars worth of gold a ton in the leached zone near the surface, from which the copper had been removed by descending solutions, leaving an iron-stained gossan. This character of ore was worked in several mines for its gold content, until the sulphide ore was encountered at a depth of 85 to 100 feet. Except for the Dairy Farm and Valley View, a depth of hardly 100 feet has been reached.

Dairy Farm Mine is in the SE $\frac{1}{4}$, Sec. 27, T. 14 N., R. 6 E., eight miles northeast of Sheridan. It was first worked for gold, which occurred with some silver in the oxidized gossan to a depth of 85 feet. Below there, a low-grade copper sulphide orebody carrying some gold was exploited. The ore is reported to have been in the form of lenses in amphibolite schist and to have averaged 3% to 3 $\frac{1}{4}$ % copper, with considerable pyrite. The mine was the principal copper producer of the county, having been worked by Dairy Farm Mining Company between 1900 and 1907 and during the war period and up to 1919 by Van Trent Mining Company as lessee. It was operated through an inclined shaft 590 feet deep with about 1000 feet of drifts and other workings on each level. After being abandoned and reported worked out, a large tonnage of low-grade stored near the railroad was shipped. During the later mining operations 350 tons of ore was mined daily, and, after sorting, the better grade was hauled by narrow gauge railroad to the Southern Pacific northwest of Sheridan for shipment to Richmond and finally to Oregon for smelting. The cost of placing ore on the cars at Sheridan was said to be about \$1.70 a ton.

Bibl: Cal. State Min. Bur. Bull. 50, p. 208; R. XV, p. 327.

Valley View Mine is in SE $\frac{1}{4}$, Sec. 12, and NE $\frac{1}{4}$, Sec. 24, T. 13 N., R. 6 E., six miles by road northeast of Lincoln. Judge J. B. Landis and Ed. Gaylord, Auburn, are the owners. Under the name of Whiskey Hill or Harpending Mine, this property was worked for gold in the sixties and had a 40-stamp mill in 1867 for crushing the oxidized gossan ore, in which gold occurred free with some metallic silver. At that time, copper in the ore was alluded to only as a subordinate metal. The oxidized shallow ore was a secondary enrichment, the iron and copper

having been leached out, leaving a soft, light and easily milled rock from which gold was cheaply extracted.

Copper sulphide and pyrite ore was found at a depth of 85 to 100 feet. There are three shafts on the property, the south shaft 130 feet deep, one on the southeast 180 feet deep, and that on the northwest end of the ore zone, 280 feet deep. At a depth of 150 feet in the southeast shaft there is a drift reported 125 feet long. From the 280-foot shaft ore was stoped from 120-foot level to the surface, and an open cut also supplied ore. The ore is in part in altered dikes which intrude the amphibolite schist country rock along the line of the dip and strike of the schistosity of the latter. The strike is N. 80° W. and the dip north-east about 72°. Zinc sulphide and pyrite in increasing quantity with lower copper content were encountered in the lower workings.

No figure of the total output is obtainable, but a number of carloads of good ore were shipped in later years. There has been no production since 1918. Samples have lately been tested to determine the feasibility of making separate zinc and copper concentrates by flotation.

The following are other *copper prospects* that have been worked only in a small way:

Name	Sec.	Location Twp.	Range	Principal working
Algol -----	9	13 N.	7 E.	2 shafts 120' deep; 200' drifts
Big Pine -----	16	12 N.	8 E.	170' shaft
Davenport -----	15	12 N.	8 E.	70' inclined shaft
Elder -----	4	13 N.	6 E.	25' shaft
Globe Cons. -----	8	12 N.	8 E.	250' inclined shaft
Greenhorn -----	Junction of Greenhorn-Bear River.			
Nevada -----	32	14 N.	8 E.	55' shaft
Thomen -----	4, 5	13 N.	8 E.	

Bibl: Cal. State Min. Bur. Bull. 50, p. 174; R. XV, pp. 327-330.

GOLD (QUARTZ MINES).

Quartz mining began in the county in the fifties, there being at present on the Pioneer Mining Company's property near Damascus the ruins of an old mill with square stamps, which was one of the earliest in the state. In spite of the immense sum recovered from its placer mines, the quartz mines have never been developed to such depths nor on as important a scale as in the counties north and south.

Beginning with the western part of the county, the most important group of quartz mines so far developed were in the Ophir District, two to four miles west of Auburn. The contact of granodiorite and amphibolite schist strikes west of northwest. Veins occur both in the granodiorite and amphibolite near the contact for several miles. They strike usually a little north of west and dip south. A great number of small 'pocket' veins occur in the amphibolite at Auburn and for several miles northwest of the town. The ore in the Ophir District shows considerable silver. Pyrite and galena are the principal sulphides, but a little zincblende and copper sulphide are seen at times. The greater number of mines at Duncan Hill and Ophir have been typically 'pocket' mines in which very rich ore has been found in bunches or small ore shoots. The occurrence of such ore in the amphibolite appears to have been affected, if not controlled, by the presence of zones in the schist which are richer in pyrite than the ordinary rock. But there have also been several mines which have contained moderate sized

orebodies of milling ore. The more important of these were the *Oro Fina*, *Hathaway*, *Gold Blossom* and *Crater*. The greatest depth reached is about 1000 feet. The veins average about two to three feet in width, but swell and pinch, especially in the amphibolite, as is characteristic with this rock.

The granodiorite intrusive undoubtedly underlies the amphibolite in the vicinity of the contact, so it may be expected that the veins will pass downward from the amphibolite into the granodiorite. Under proper geologic conditions, the veins should continue in the granodiorite. The deepest developments here have been in the granodiorite. All of the deepest work at Grass Valley, Nevada County, has been in granodiorite. None of the quartz mines in the district are active. The *Oro Fina* was the last operated, and is described as an example.

About a mile east of Penryn is a group of small quartz mines which were active between 1860 and 1885. These are in the granodiorite and produced low and medium grade ore. The deepest work was about 600 feet at the Chicago.

The Mariposa slate of the Mother Lode belt enters the county near Weimar. The Black Oak Mine has been profitably worked there, but development has been limited. There have also been some 'seam diggings,' where free gold occurs in the slate in quartz seams and has been mined by hydraulicking the soft upper oxidized zone, as was done in the nearby Spanish Dry Diggings and Georgia Slide districts in El Dorado County.

The most important quartz gold producer in the county was the Rising Sun, a mile and a half west of Colfax. A long tunnel is being run there to give drainage preparatory to new prospecting.

From the Middle Fork of American River, three miles south of Bath, there extends northward with interruptions a belt of peridotite and serpentine derived from it. West of it lies a belt of amphibolite schist. The two rocks may be traced almost due north to Alleghany and Downieville, Sierra County. Along their contact, and in the amphibolite schist near it, pocket mines have been opened in a small way with profit. Probably this pocket belt, of which a large part was undoubtedly covered by later andesite flows, enriched the gravel of the ancient streams which flowed across it. The Garbe and de Maria Mine in Ladies Canyon has produced many thousands of dollars worth of beautifully crystallized gold and is still operated. The Four Aces Mine is also active in Volcano Canyon. The serpentine contains bodies of talc schist, mariposite and barite. Finely divided gold occurs in places in the talc, but is difficult to recover.

Four miles southeast of Towle in the large area of Carboniferous rocks locally called the Blue Canyon formation, are found many prominent veins of quartz. Most of these have been prospected and many have been productive. The Blue Canyon formation is composed principally of black clay slate and quartzitic sandstone. Igneous dikes are often to be seen accompanying the veins. The Pioneer Mine on the Pioneer and Lynn veins, has been the largest developed. The Black Hawk and American Eagle mines are active now on a small scale. The Pioneer operations are described herein. The American Bar, and the Herman, Black Canyon and Canada Hill mines, farther east in the high mountains, are in the Blue Canyon formation, which is the bedrock

formation of most of the higher eastern part of the county. The first and last named are active.

American Eagle Prospect is in the canyon of North Fork of American River, a mile and a half upstream from the mouth of Humbug Creek, and reached by a trail from Towle or from the Pioneer Mine. There is a quartz vein four feet wide where opened in prospecting five years ago. The footwall is black slate and hanging wall gray schist. A little work has been done at intervals by a stock company, under different names. A 10-stamp Straub mill has lately been installed. A total of about 240 feet of underground work is reported.

Big Ben Mining Company was not successful in developing free-milling ore on its property five miles north of Lincoln. A large sum was raised from the sale of stock and considerable prospecting done to a depth of 360 feet. The prospect is in amphibolite schist near the granodiorite contact.

Black Hawk Mine is on the North Fork of American River, four miles southeast of Towle by trail. A. B. Chase and others of Roseville have moved 10 stamps of the old Southern Cross mill to the claims and were erecting them in July, 1927, preparatory to crushing ore. The property was first developed years ago, and Chase believes some of the quartz then broken will pay to mill and that there are good prospects in the adit workings.

Canada Hill Mines comprise two groups of claims, the Beauty Group of ten claims and Nob Hill Group of seven claims, each covering 4500 feet on the strike. They are at Canada Hill, 44 miles from Auburn via Forest Hill, and the elevation is 6225 feet at the Beauty shaft. A 30-ft. shaft and an upper adit 200 feet long gave good prospects in a quartz vein one and one-half to three feet wide and striking northeast. In 1919 and 1920, Metals Exploration Company prospected it under lease and option. A lower adit was run 800 feet, of which 600 feet was a crosscut. They gave up their option in 1920. Since then Snyder has resumed work and some ore is reported being crushed in a 10-stamp mill during the present year. The Nob Hill claims have been prospected by adits. The veins are of fair size and assayed well at the surface.

Centennial Mine on Duncan Hill, two miles southwest of Auburn, is an example of a type common in the district. The vein is about 30 inches wide, in amphibolite schist, but pinches down at intervals. It strikes N. 80° W. and dips 70° south. The ore occurred in small rich shoots, from two to fifty feet long, the formation of which appeared to have been influenced by 'iron crossings,' the miners' term for zones rich in pyrite and chalcopyrite in the amphibolite schist. Ore was mined in 11 or 12 shafts, the deepest 180 feet. After this, adits were run from each end of the claim, one 700 feet long and the other 900 feet, connecting a few feet apart vertically at one of the shafts. The plan was to mill the entire vein, but this was unsuccessful. The total production was \$150,000 or more. The estimated value of ore in the rich shoots was \$8 to \$12, but the vein as a whole is low grade. The Booth, Conrad and Crandall are nearby mines which have all made some production, but are all idle. The ore of Duncan Hill contains gold, silver, lead and copper, the sulphides being rich at times.

Chicago Mine was an example of mines in the granodiorite near Penryn. Several small quartz mines were worked between 1860 and 1885 about a mile east of the town. A vein of solid quartz two to three feet wide strikes N. 20° to 30° E. and dips from 70° east to vertical at the Chicago. On the north end it breaks into stringers. A shaft was sunk 500 feet. For the first 200 feet the ore is stated by a former superintendent to have averaged \$7 a ton. Ore was mined for a length of 400 feet on the 300-ft. and 400-ft. levels, but ran as low as \$4 a ton there. Around 500 feet deep the vein was breaking into stringers. The walls were hard and stood well without timber. All mining was by hand. A 10-stamp mill was operated. The Alabama and Elizabeth were nearby mines worked at the same time. The placer mines along Secret Ravine, which drains this district, were enriched by erosion of these veins.

Four Aces (formerly *Three Queens*) *Mine* is part of a group of 14 claims, said to cover 10,500 feet along a dike of serpentine and its contacts with schists, and extending from the Spanish Mine southeast of Forest Hill to the Middle Fork of American River. A road three miles long from Forest Hill drops 1800 feet in reaching the camp, which is on Volcano Canyon at an elevation of 1360 feet and one mile north of the river.

Some work was done here and about \$45,000 was produced a number of years ago by George Wingfield. The pay ore was taken from a small 'pocket' orebody only a few feet underground. The area mapped as peridotite and serpentine contains strips of black, graphitic schist and completely altered rock, evidently igneous dikes originally. The serpentine is also altered to talc and mariposite in places. To the west lies amphibolite schist, and strips of this also occur in the serpentine, the graphitic schist probably also being a phase of it.

A total of 550 feet of underground work had been done here to July, 1927, entering near the level of Volcano Canyon. Of this, 430 feet was drifting. A quartz vein three to four feet wide where stoped, strikes northwest and dips 30° to 40° northeast. It has the black graphitic schist and altered dike on the hanging wall and mariposite on the footwall, in those places where the best ore is reported. Three stopes, the longest being 90 feet, have been opened. High-grade ore occurs in small bunches showing considerable free gold in this vein. This high grade evidently formed along the hanging wall, by repeated opening, and gold was precipitated by graphite and carbonates in the schist. Orebodies will probably be confined to the veins at the contact of amphibolite, black schist or dikes with the serpentine, the last named alone being unfavorable for vein formation. Near the southeast end of the drift, 348 feet from the portal, a floor dips N. 20° W. Gold occurs in the filling of this flat seam. It appears as if such seams might be caused by the slipping of the hillside and the presence of gold in them might be due to secondary, downward enrichment.

About 1000 feet southeast from the face of this drift there is a winze 148 feet deep on the Scorpion claim. To the northwest, 1250 feet away, 120 feet of workings were run along the contact and good assays reported.

The equipment includes a 5-stamp mill, 40-h.p. semi-Diesel engine,

air compressor and several good buildings. Ten to 15 men are employed.

Oro Fina has been the only important producer in the Ophir District in the past ten years. It is about four miles by road west of Auburn. The vein as a rule is about two feet wide, but pinches in places, forming lenses. Both walls are amphibolite schist to between the 600-ft. and 700-ft. levels, where the vein enters the granodiorite, which on the surface lies a short distance south. The vein was of lower grade in the contact zone, but reported of good grade where it entered the hard granodiorite, and was not displaced laterally.

The new shaft on Bullion No. 1 claim was sunk 730 feet and six levels were opened at 100-ft. intervals. The last owners, Oro Fina Mining Company, began work in 1913 and continued until January, 1922, when the death of the manager resulted in closing the mine and shortly after all machinery and equipment were removed.

The vein strikes a little north of west and dips 65° south. Levels were run east from 300 to 1400 feet and from 130 to 500 feet west, developing ore shoots on both sides of the shaft, one of them 150 feet and the other 250 feet long. The larger of these is east of the shaft, and No. 7 level was being driven to reach it, with several hundred feet still to go at the time of closing. This section is still well above the contact zone. The sulphide content of the vein averaged 1% pyrite, worth \$60 a ton. The ore averaged within a few cents of \$8 a ton between 1915 and 1921. The production for five years ending December 31, 1920, was \$430,000. There was a good profit from operation until high prices incidental to war conditions ensued. The total cost of operation and development rose from \$5.55 in 1916 to \$7.85 a ton in 1917. The mill used (since removed) contained rock breaker, ten 1000-lb. stamps, and one each sand and slime concentrators. It had a capacity of 35 to 40 tons a day and made a satisfactory recovery, most of the gold being free. The ore of this mine appears to differ from that of many of the mines in the granodiorite nearby, which carry sulphides of lead, copper, zinc and silver. One small body of rich ore at the Oro Fina produced \$90,000.

Pioneer Mine, on the south side of the canyon of American River, five miles south of Towle, is probably the deepest and most extensively worked quartz mine in the county. The steep topography permitted the use of adits, giving a depth of 1440 feet below the apex. Little work has been done in the past four years.

There are two veins, the Lynn and Pioneer, but most of the work was on the Lynn. It strikes N. 32° W. and dips 70° NE. The vein follows a strong dike most of the way, and this favors persistence in depth. This vein is one to ten feet wide, but averages four to seven feet wide in most places and is composed of good-looking ribbon rock. The footwall is hard black slate and the hanging wall grey slate and slaty schist.

No. 3 crosscut adit cuts the Pioneer vein at a distance of 390 feet and the Lynn vein at 1400 feet from the portal, and at a depth of 700 feet, and follows the latter 2525 feet. No. 7, 525 feet below No. 3, is a crosscut 2800 feet long to the Lynn vein and is drifted on that vein for 1475 feet. A winze is sunk 242 feet below No. 7 adit, showing the vein to be two to $9\frac{1}{2}$ feet wide on the bottom level, where it was drifted 225 feet. Thirteen levels in all were run. Between No. 3 and No. 4 levels,

the vein was stoped nearly continuously for about 1200 feet. The North Lynn stope was 300 feet by 700 feet long and 1 to 4 feet in thickness was stoped; Lynn stope was 325 feet by 450 feet by one to six feet. There has been little mining below No. 5 level.

The ore milled has ranged from \$3 to \$16 a ton, running \$10 to \$16 a ton in the upper levels. It contains $2\frac{1}{2}\%$ of pyrite, worth about \$50 a ton. One section of vein $2\frac{1}{2}$ inches wide above No. 7 level is reported to have yielded some ore worth \$120 a ton.

The mill is 550 feet below No. 7 adit. It was built 40 years ago and it contains 9" by 12" breaker, twenty 1050-lb. stamps and six 4-ft. belt vanners. There is also a cyanide plant with a capacity of a ton a day for treating concentrate. Electricity brought from Towle was used for power in recent years. The later operations have been intermittent and the tramway from No. 7 to the mill, the electric power line and the mill are in need of repairs. The mine's production can not be definitely stated, but is believed to have been between \$600,000 and \$900,000.

Rising Sun Mine is a mile and a half west of Colfax. It was opened in 1866 and was operated until 1874 with a 5-stamp mill, and from then until 1880 with a 10-stamp mill, which crushed 12 to 15 tons a day. The production was over \$2,000,000.

The vein averaged 18 inches wide in the upper levels and lies between hard diabase walls. It strikes northeast and dips 85° south to the seventh level, where it rolls over and reverses its dip in 20 feet. Below this roll the vein increases in width to four or five feet and becomes softer. The deepest shaft is 749 feet deep on the dip with ten levels. There are two other shafts to the west, one sunk to the fifth level and the other to the third. On the west of main shaft there was a pay chimney about 40 feet long, which is reported by a former superintendent to have been so rich in free gold near the cross fault that the gold literally held the quartz together. A north and south crossing or fault apparently bounded the rich ore on this side and had probably influenced its deposition. East of the shaft, pay was in stringers. On the west it paid well to the 700 level, where the roll occurred, but below there it is said to have milled \$5 a ton.

The mine lay idle from 1884 to 1919, when a stock company erected a modern plant with a new 10-stamp mill and unwatered the mine. They were unable to keep the water out of the lowest level long enough to do any work and failed to find any new ore. They quit in 1921 after milling a few tons. Subsequently E. C. Klinker began further work and lately a long drain tunnel, planned and started 12 years or more ago, has been continued, and it was expected that this would be finished the present summer.

Spanish Mines, lying north of the Four Aces property, show a vein of barite, silica and talc in the form of a blanket divided into floors in which free gold occurs. It has a 2-stamp mill.

Snowbird Mine, near the old Sugar Pine mill $12\frac{1}{2}$ miles northeast of Forest Hill, shows free gold in talc and serpentine with a little quartz. It is equipped with a 50-ton ball mill, five light stamps and a small cyanide plant. The company that put this equipment on it was unable to make it pay.

Following the plan used in our new set of county reports, the writer has not considered it necessary to enter into a description of each quartz mine in the county. This would involve the repetition of many details covered in past reports. It is also true that many mines in the same district or in the same geological formations have many characteristics in common, so that a description of one or two of each type, with the results obtained in their operation, gives the reader a good idea of what may be expected from others of the same type. The above notes summarize the results of quartz mining in the county since the reports of 1915 and 1920. The following table shows in compact form the name, location and ownership of all quartz mines and prospects and a bibliography of articles concerning them in our past publications. The quartz mines of the Ophir district were described in the Fourteenth Report of the U. S. Geological Survey, part two, and the areal geology of the county was mapped by that survey in its Sacramento, Placerville, Colfax and Truckee folios.

TABLE OF QUARTZ MINES AND PROSPECTS, PLACER COUNTY.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Adams-----	20	12 N.	8 E.	Calvin T. Adams, Newcastle-----	1,050		R. XIII, p. 272; XV, p. 331.
Alameda-----	25	14 N.	9 E.	J. F. Wise and Martin Partridge, Colfax-----	1,400		R. XV, pp. 331-332.
American Bar-----	33	14 N.	11 E.	American Bar Quartz Mining Co., John McCand- less, Pres., Harry A. Kunz, Secy., 858 Mills Bldg., San Francisco-----			
	4, 5	13 N.	11 E.		1,800		R. XII, p. 204; XIII, p. 273; XV, p. 332; XVIII, pp. 261-262; XIX, p. 141; XX, pp. 13, 81-82, 179; Pre. Rep. 8, p. 31.
Anchor Mining Co.-----				C. N. Parmenter, Roseville-----			See Dorer.
Andy Farrier Diggins-----							See Langstaff and Storey.
Annie Laurie-----	24, 25	14 N.	9 E.	Young & Major, Mrs. V. M., Weimar-----	2,000		R. XV, p. 332.
Australia-----	25	15 N.	10 E.	Australia Quartz Mining Co., c/o Eleanor Meeks, 1202 Arguello Blvd., San Francisco-----		77	
Bazaeoo-----	22, 26	13 N.	9 E.	Sheridan Brothers, Butcher Ranch-----	1,700		R. XV, p. 332.
Beauty-----	9	15 N.	13 E.	Henry Snyder, Grass Valley-----	6,200	40	R. XV, p. 332.
Belle Union-----	35	14 N.	9 E.	D. Jones, Clipper Gap-----	2,000		R. XIII, p. 273; XV, p. 332.
Bellevue-----	7, 8	12 N.	8 E.				R. XIII, p. 274; see Oro Fina.
Belvoir-----	18	12 N.	8 E.	J. Kaiser, Ophir-----	1,000		R. XV, p. 332.
Big Ben Cons.-----	25	13 N.	6 E.	Big Ben Cons. Mining Co., Lincoln-----		67	
Big Blue-----	3	15 N.	10 E.	Moody & Garety, Gold Run-----	3,050		R. XIII, p. 274; XV, p. 332.
Big John-----	25	14 N.	9 E.	Ed. Bigley, E. B. Odell, M. L. Odell, E. H. and M. A. Hinchey, Weimar-----	2,200		R. XV, pp. 332-333.
Big Oak Tree-----	33	15 N.	9 E.	Wallace Werry, 2215 H St., Sacramento, and D. A. Russell, Colfax-----	2,300	9	R. VIII, p. 463; XIII, p. 274; XV, p. 333; XX, p. 179.
Bishop-----							R. XIII, p. 274.
Black Canyon-----	2, 3	15 N.	12 E.	Black Canyon Quartz Mining Co. of California, c/o E. B. Quigley, Forest Hill-----			
Black Hawk-----	8, 10	15 N.	12 E.				
Black Oak-----	4	15 N.	11 E.	A. B. Chase, Towle, et al.-----	5,500		R. XIII, p. 274; XV, p. 333.
	35	14 N.	9 E.	Black Oak Mine, c/o Elsie A. Drexler, 1068 Mills Bldg., San Francisco-----			
Black Spanish No. 2-----	7	12 N.	8 E.	J. E. Walsh, East Auburn-----	1,875	80	R. XIII, pp. 274-275; XV, p. 334.
Blue Bell-----	3	15 N.	11 E.	A. Percival Crittenden, Towle-----	3,000		R. XV, p. 334.
Blue Jay-----	31, 32	14 N.	11 E.	Lorenzo de Maria, Butcher Ranch-----			R. XV, p. 334.
Blue Wing-----	28	15 N.	10 E.	W. A. Hilliard, Grass Valley-----	2,800	40	R. IX, p. 29; XV, p. 334.

Bonanza-----	11	15 N.	11 E.	Jerry J. Sullivan, San Francisco-----	3,200	----	R. XV, pp. 334-335.
Bonnie Bee-----	3	16 N.	11 E.	Bonnie Bee Quartz Mining Co., 744 Lake Shore Ave., Oakland-----	3,450	----	R. XV, p. 335.
Bonnie Bell-----	18	16 N.	11 E.	Bonnie Bell Quartz Mining and Development Co., Dutch Flat-----	----	----	----
Booth-----	8, 9	12 N.	8 E.	} Slosson & Spinney Estates, c/o E. P. Slosson, Auburn-----	1,380	10	R. XVII, pp. 442-443.
	16	12 N.	8 E.		950	----	R. XII, pp. 205-206; XIII, p. 275; XV, p. 335.
	18	12 N.	8 E.		----	----	See Julian Mine.
Boulder-----	2, 3	15 N.	11 E.	Wm. M. Bree-----	----	----	R. XVIII, p. 301.
Bree-----	24	14 N.	9 E.	Ed. Bigley, Colfax-----	3,000	----	R. X, p. 426; XV, p. 335.
Buena Vista-----	7, 8	12 N.	8 E.	----	1,240	----	R. XIII, p. 275.
Bullion-----	32	14 N.	11 E.	H. H. Bunker and J. A. Nihill, Michigan Bluff-----	----	----	R. XV, p. 335.
Bunker & Nihill-----	14	13 N.	9 E.	J. W. Burner, Forest Hill-----	----	----	R. XV, p. 335.
Burner-----	21	12 N.	8 E.	----	----	----	See Hathway.
Butts-----	34	13 N.	8 E.	W. E. Dean, Kohl Bldg., San Francisco-----	1,000	----	R. VIII, p. 461; XIII, p. 276; XV, p. 335.
Calf Pasture-----	16	12 N.	8 E.	Mr. Hubbell, Auburn-----	----	----	R. XIII, p. 276; XV, p. 335.
California-----	33, 28	15 N.	13 E.	F. G. Albonos, Michigan Bluff, A. C. Lowell, San Francisco-----	----	62	Field Report.
Carter, Wallace & Augustine-----	17	12 N.	8 E.	H. M. Black and H. J. Ellert, Virginia City, Utah-----	5,900	----	R. XV, p. 336.
Cash in Dump-----	3	15 N.	11 E.	Wm. Walsh, Auburn-----	5,400	10	R. XV, p. 336; XVII, p. 443; XVIII, pp. 263, 301-302.
Centennial-----	15	14 N.	11 E.	Central Mining Co., H. T. Power, Pres., Berkeley-----	2,200	21	R. XV, p. 336.
Champion-----	32	16 N.	14 E.	Daniel Webster Mining Co., c/o F. A. Leach, A. Dibble and Mr. Hampton, Michigan Bluff-----	----	----	R. XII, p. 206; XIII, p. 276; XV, p. 336.
Cherokee-----	35, 36	12 N.	7 E.	Tom Young, Cisco-----	5,200	----	R. XII, p. 206; XIII, p. 276; XV, p. 335.
Chicago-----	26	13 N.	9 E.	Estate of John F. Howard, Penryn-----	1,800	----	R. XV, p. 337.
Christmas Hill-----	17	12 N.	8 E.	J. A. Ware, Butcher Ranch-----	1,150	15	See Three Stars.
Columbia-----	8	12 N.	8 E.	Wm. Walsh, Auburn-----	950	37	R. XV, p. 337; XVII, pp. 443-444.
Conrad-----	12	12 N.	7 E.	T. F. Jull, Auburn-----	1,200	----	R. X, p. 433; XII, p. 207; XIII, p. 277; XV, p. 337.
Crandall-----	25	13 N.	6 E.	George A. Aldrich, Auburn-----	----	17	----
Crater Hill-----	----	----	----	F. C. Crosby, Lincoln-----	----	----	----
Crosby-----	----	----	----	----	----	----	----

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TABLE OF QUARTZ MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Cuckoo	16, 4 9, 10 12	14 N. 14 N. 16 N.	12 E. 12 E. 11 E.	c/o F. N. Tillotson, Michigan Bluff			
Dahlonga				Dahlonga Mining Co., 470 Count St., San Bernardino	5,350	6	R. XIII, p. 277; XV, p. 337.
Daniel Webster	15, 16 22	14 N. 14 N.	11 E. 11 E.	Daniel Webster Mining Co., c/o F. A. Leach, A. Dibble and Mr. Hampton, R. H. Summers, Michigan Bluff	3,600		R. XII, p. 207; XIII, p. 277; XV, p. 337; XX, p. 13.
Debb	4	15 N.	11 E.	A. Percival Crittenden, Towle	3,850		R. XV, p. 338.
De Maria				C. J. deMaria and Mr. Garbe, Spring Garden			R. XV, p. 338; Pre. Rep. 8, p. 32.
Dewey	22	13 N.	9 E.				R. XV, p. 338.
Dewey & Stocker	30	14 N.	11 E.	Mrs. R. B. Howell, Auburn; Mrs. E. S. Jensen, Sacramento		35	R. XIII, p. 277; XV, p. 338.
Don Prospect				John Lass and Walter J. Wren, Virginia City, Utah	6,700		R. XV, p. 338.
Dorer	3	15 N.	11 E.	L. R. Dorer, Auburn	4,016		R. VIII, p. 468; XII, pp. 207-208; XIII, p. 277; XV, p. 338.
Drummond	1	14 N.	10 E.	Estate of C. F. Reed; J. E. Walsh, Freeman Hotel, Auburn	3,600		R. X, p. 424; XII, p. 208; XIII, p. 277; XV, p. 338; Pre. Rep. 8, pp. 31-32.
Dry Hill	31, 32 2, 3	14 N. 15 N.	11 E. 11 E.	Clementina deMaria, McKeon			R. XV, p. 338.
Eagle				Wm. M. Bree and Eagle Gold Mining & Milling Co., 427 Western Mutual Life Bldg., Los Angeles	2,000		R. XVIII, p. 301.
Eclipse	17	12 N.	8 E.	Eclipse Milling Co., Auburn	1,000		R. X, p. 433; XIII, p. 277; XV, p. 338; Bull. 50, p. 207.
Elizabeth				John Watson, Penryn			R. XVII, p. 445.
Ellen Dip					900	69	See Golden Scepter.
Eureka	13	12 N.	7 E.				R. XV, p. 339
Eureka Cons.	1 31	13 N. 14 N.	9 E. 10 E.	C. F., Wm. and G. Seavey, W. A. Shepherd, H. Adams and G. Coffin, Forest Hill	2,000		R. XV, p. 339.
Falls Creek							See Chicago.
Fall Ravine	14	15 N.	13 E.	M. Savage, Forest Hill	6,000		R. XII, p. 208; XV, p. 339.

Flat Ravine	27	15 N.	13 E.	Flat Ravine Quartz Mine, 242 Polk St., San Francisco			R. XII, p. 208; XIII, p. 278. (Herein.)
Four Aces				M. Savage and Four Aces Mines Co., Forest Hill			
Galma, Patrick & Patrick extension, Tunnel Mine				Black Canyon Quartz Mining Co., c/o E. B. Quigley, Forest Hill			See Black Canyon. See de Maria. R. XV, p. 339.
Garbe	2	15 N.	11 E.	John Rablin, Dutch Flat	3,200		
Gem	12	12 N.	7 E.	Reed Estate, Auburn; J. H. Toler, Mgr.; A. C. Lowell, executor	700		R. X, pp. 431, 433; XII, p. 209; XIII, pp. 278-279; XV, pp. 339-340.
Golden Eagle	5	15 N.	13 E.	Mrs. Thos. Bailey, Box 245; Nevada City, et al.		20	R. VIII, p. 464.
Golden Reward	17	11 N.	8 E.	Mrs. Wm. Bell & Son, Westville	6,000		R. XV, p. 340.
Golden Rule	3	13 N.	8 E.	Wm. Kendall, Sacramento	750		R. XV, p. 340.
Golden Scepter	27	14 N.	11 E.	Ed. Vore, Applegate and E. Ephraim	1,625		R. XIII, p. 279; XV, p. 340.
Golden Sheaf				Golden Sheaf Mining Co., E. P. Thompson, Mgr., Michigan Bluff			R. XV, p. 340.
Golden West	25	16 N.	11 E.	Reuben H. Lloyd, San Francisco	3,000		R. XV, p. 341.
Gold King	8	15 N.	13 E.	Jas. G. Dodds, Elizabeth Bell and Nels Forthun, Westville	5,860	20	R. XV, p. 340.
Great Eastern	20	16 N.	12 E.	Great Eastern Quartz Mine, Emigrant Gap		15	
Great Western	21	15 N.	13 E.	Great Western Mining Co., Mr. Kelly, Pres., Martin Winters, Secy., Pier 36, North River, N. Y.	5,000	270	R. XV, p. 341. R. XII, p. 209; XIII, p. 280; XV, p. 341.
Green	8	12 N.	8 E.	Wm. Kendall, Dutch Flat			See Dewey & Stocker.
Green Emigrant	29	13 N.	8 E.	R. A. Nicol, 67 Sunshine Ave., Sausalito	1,600	10	
Hancock & Watson				G. B. Hannaman, Auburn	1,200	120	
Hannaman	18	12 N.	8 E.		675	24	R. X, pp. 429-431; XIII, p. 280; XV, p. 341.
Hathway				J. T. Curry, Forest Hill	4,500	1,448	R. VIII, p. 472; IX, p. 29; XII, p. 211; XIII, p. 280; XIV, pp. 341-342.
Herman	16	15 N.	12 E.	John Lass, Summit	5,500	20	R. XV, p. 342.
Hermit	30	15 N.	18 E.	Andrew Johnson, Ophir	1,142		R. XV, p. 342.
Hope	17	12 N.	8 E.				R. XIII, p. 281.
Huntville Cons.				Patrick McInnis, Butcher Ranch			R. XV, p. 342.
International	12	13 N.	9 E.	John Lass, Virginia City and L. D. Heath, Los Angeles			
Joe Dandy				J. D. Sullivan and A. P. Crittenden, Towle	6,936		R. XV, p. 342.
Julia	3	15 N.	11 E.	Mrs. Martin Schnabel, Newcastle			R. XIII, p. 281; XV, pp. 342-343.
Julian	7	12 N.	8 E.				R. XV, p. 343.

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TABLE OF QUARTZ MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Kittler	12	12 N.	7 E.		1,000		R. XIII, p. 382.
Lady Bedford							See Rip Van Winkle.
La Follette	7, 8	15 N.	13 E.	Henry Snyder, Grass Valley	5,930	20	R. XV, p. 343.
Langstaff & Storey							Pre. Rep. 8, p. 32.
La Trinidad	34	16 N.	13 E.	George Montgomery, Mills College P. O., Cal- ifornia			R. XV, p. 343.
Liberty	2	15 N.	16 E.	C. W. Cross; Wm. Maguire, Nevada City	6,000		
Little Banner	30, 31	15 N.	14 E.	Charles Glover			R. XV, p. 343.
Little Ginger	22	12 N.	8 E.				
Live Oak	33	15 N.	9 E.	D. B. S. Wilcox, Colfax		18	
	23	14 N.	9 E.	G. and W. P. Geisendorfer, Weimar	2,000		R. VIII, pp. 474-475; IX, p. 29; XIII, p. 282; XV, pp. 343, 364.
Lost Emigrant	32	16 N.	14 E.	F. L. Heath, Donner P. O., Placer county, Cali- fornia, et al.	6,700		R. XV, p. 344.
Lundquist	16	12 N.	8 E.	Mrs. Lundquist, Auburn			R. XIII, p. 282; XV, p. 344.
Lynn				(Part of Pioneer)			R. VIII, p. 468; See Pioneer also.
Malmberg	16	12 N.	8 E.	J. Malmberg, Auburn			R. XIII, p. 282; XV, p. 344.
Marguerite	3	12 N.	8 E.	Unknown—sold to state	1,360		R. XII, p. 210; XIII, pp. 282 283; XV, p. 344; XVIII, p. 45.
Mars				Sam Wolford, Grass Valley	2,428	80	R. XV, p. 334.
Midas							See Shady Run.
Minna Ricca	17	12 N.	8 E.	J. E. Walsh, East Auburn	1,000		R. X, p. 433; XV, p. 345.
Mitchell				H. F. Adams, Forest Hill and estate of Ben Tabor, Auburn			
Mollie or Mollie Stark	21	12 N.	8 E.	Mrs. Asa B. Eastwood, Newcastle	850		R. XV, p. 345.
Moore	17	12 N.	8 E.	J. M. White, Auburn	1,050		R. XV, p. 345.
Nob Hill							R. XIII, p. 283; XV, p. 345.
No Chunk							See La Follette.
North Star	22	13 N.	9 E.	E. J. Power, E. J. Young and Henry F. Power, Berkeley			R. XIII, p. 284.
North Star				North Star Mining Co., c/o Chas. Thomas, Box 107, Truckee	1,700		R. XV, p. 345.
Number Two	10	15 N.	10 E.	E. A. Moody and Mr. Garety, Gold Run	2,875		R. XIII, p. 284; XV, p. 345.
Ohio							R. VIII, p. 480.
Old Pacific	25	12 N.	7 E.	Mrs. Martin Schnabel, Newcastle			R. XII, p. 211; XIII, p. 284; XV, p. 345.

Oro Fina-----	7, 8	12 N.	8 E.	Mrs. Haines Gridley, Auburn-----	1,140	96	R. XIII, p. 274; XV, p. 345-346; XVII, pp. 445-446; XVIII, p. 7; Pre. Rep. 8, p. 32.
Osborne-----	-----	-----	-----	-----	-----	-----	See Herman.
Ostrom-----	-----	-----	-----	-----	-----	-----	See Blue Wing.
Pacific Slab-----	-----	-----	-----	-----	-----	-----	See under Placer Mines.
Page & Buckman-----	-----	-----	-----	-----	-----	-----	See Rip Van Winkle.
Paragon-----	-----	-----	-----	-----	-----	-----	See under Placer Mines.
Patrick Cons.-----	10	15 N.	12 E.	G. W. Snyder, Damascus-----	4,800	-----	R. XV, p. 347.
Pioneer Cons.-----	3, 4	15 N.	11 E.	Pioneer Mining Co., Room 525 Clunie Bldg., 519 California St., San Francisco-----	3,800	728	R. VIII, p. 468; X, p. 426; XII, pp. 211-212; XIII, p. 284; XV, p. 347; XVIII, p. 302; Pre. Rep. 8, p. 32.
-----	9, 10	15 N.	11 E.	-----	-----	-----	R. XV, p. 347.
Prairie Flower-----	9	15 N.	13 E.	Mrs. Wm. Bell & Sons, Westville-----	5,800	40	-----
President Wilson-----	20	15 N.	12 E.	J. W. Cairns, Weimar-----	5,200	120	-----
Pritchard Gravel-----	-----	-----	-----	-----	-----	-----	See Blue Wing.
Providence-----	-----	-----	-----	-----	-----	-----	R. XX, p. 179.
Quien Sabe-----	9	15 N.	13 E.	Peter Hinst and J. G. Dodds, Westville-----	5,300	40	R. XV, pp. 347-348.
Rawhide-----	4	15 N.	11 E.	Canyon Mines Corp., Hotel Sutter, San Francisco-----	3,400	-----	R. XV, p. 348; XVIII, p. 302; Pre. Rep. 8, p. 32.
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Razzle Dazzle-----	20	12 N.	8 E.	G. L. Threlkel, Newcastle-----	950	-----	R. XV, p. 348.
Reciprocity-----	11	12 N.	7 E.	I. Meyer, Lincoln-----	595	-----	R. XV, p. 348.
Red Bird Cons.-----	24	14 N.	9 E.	G. A. Tubbs, Colfax-----	2,000	-----	R. XV, p. 348.
Red Rock-----	24	16 N.	11 E.	N. B. Willey, Blue Canyon-----	4,200	-----	R. XIII, p. 285; XV, p. 348.
Rip Van Winkle-----	28	15 N.	12 E.	Martin S. Buckman, Shelbyna, Missouri-----	3,200	42	R. XII, p. 210; XIII, p. 282; XV, p. 348.
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Rising Sun-----	33, 34	15 N.	9 E.	Benj. E. Valentine-----	2,290	440	R. VIII, p. 462; XIII, p. 285; XV, p. 349; XVII, pp. 446-447; XVIII, p. 7; Pre. Rep. 8, pp. 32-33.
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Roosevelt-----	4	15 N.	14 E.	F. L. Heath, Donner, et al.-----	-----	-----	R. XV, p. 349.
Rublin-----	34	15 N.	12 E.	Messrs. Foley, McCarty & Caren, Chicago-----	-----	-----	R. XV, p. 349.
Ruby-----	25	14 N.	9 E.	E. H. Hinchey, Weimar-----	2,200	-----	R. XV, p. 350.
Saint Lawrence-----	7	12 N.	8 E.	Reed Estate, Auburn-----	1,000	-----	R. XV, p. 350.
Salig-----	3	12 N.	8 E.	A. L. Smith, Auburn-----	1,200	-----	R. XV, p. 350.
Salsic-----	3	12 N.	8 E.	Smith & Fulweiler, Auburn-----	1,300	-----	R. XII, p. 212; XIII, p. 285; XV, p. 350.
-----	-----	-----	-----	-----	-----	-----	-----
Secret Town-----	10	15 N.	10 E.	E. A. Moody and J. E. Everhart-----	2,875	-----	R. XIII, p. 285; XV, p. 350.
Senator Gold and Copper-----	-----	-----	-----	J. W. Cairns, D. M. Kennedy, Weimar, and C. E. Van Giesen, Applegate-----	2,000	80	Field Report.
Shady Run-----	27, 28	16 N.	11 E.	Shady Run Mining Co., Joseph Fyfe, agent and trustee-----	2,700	640	R. XV, p. 350.

*Due to various legal complications which may arise regarding ownership of unpatented mining claims, we do not vouch for absolute correctness of this column The names are mostly those appearing on the tax rolls. To save space, frequently only one of several owners is listed.

TABLE OF QUARTZ MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Sheridan							R. VIII, p. 468.
Smith & Fulweiler							See Salsic.
Snowbird	21	15 N.	11 E.	George McCullough & Lewis, Forest Hill	3,950	20	R. XVII, p. 447; Pre. Rep. 8, p. 33.
Snowflake							See Prairie Flower.
Southern Cross	4	15 N.	11 E.	R. L. Ford, Towle; A. W. Nicholls, Berkeley-			R. XII, p. 212; XIII, p. 286; XV, p.
							80.
Spanish	7	12 N.	8 E.	Reed Estate, Auburn	1,050		R. XIII, p. 285; XV, p. 351.
Spanish	25, 26	14 N.	11 E.	E. A. Garrison, Forest Hill	2,850	143	Field Report.
	30, 31	14 N.	11 E.				R. VIII, pp. 461-462; XII, p. 212;
St. Lawrence	7	12 N.	8 E.		1,000		XIII, p. 286.
Sterrett							See La Trinidad.
Sumpter							R. VIII, p. 475.
Texas	20	16 N.	12 E.	Halsey Estate, Towle; J. L. Gould, Alameda, Pres.			R. XIII, p. 286; XVIII, p. 286; XV,
					5,600		p. 351.
Three Stars	2	12 N.	7 E.	Columbia Gold & Silver Mining Co., E. H. Vance, 1911 Webster St., Oakland	650		R. XII, p. 206; XIII, pp. 276-277;
							XV, p. 351.
Tiger, Buena Vista and Ruby	25, 27	14 N.	9 E.	E. H. Hinchey, Weimar	2,200	23	R. XV, p. 351.
Tryon	1	15 N.	10 E.	Dr. W. M. Tryon, 409 Pacific Bldg., San Fran-			
				cisco and W. N. West, Towle		24	
Two Orphans	30	13 N.	8 E.	Ed. Bell, Auburn	1,480	21	Field Report.
Tyler							R. XV, p. 351.
Van Avery	14	16 N.	11 E.	L. Balliet, San Francisco	4,625		R. XV, p. 351.
Van Giesen	10	13 N.	8 E.	C. E. Van Giesen, Applegate	1,800	41	Field Report.
Washington	30	14 N.	11 E.	A. M. Nihill, Nevada and Jack Nihill, Michigan Bluff	3,400		R. VIII, pp. 466-467; XII, p. 286; XV,
							pp. 351-352.
Westlake	14 mi.	SE. of Cisco		M. Westlake			
White Oak	14	11 N.	10 E.	J. N. Barton, Jr., Estate	2,810	80	Field Report.
Wubben	32	16 N.	14 E.	Herbrant, Eustice & Co., Woodland	6,500		R. XV, p. 352.

*Due to various legal complications which may arise regarding ownership of unpatented mining claims, we do not vouch for absolute correctness of this column. The names are mostly those appearing on the tax rolls. To save space, frequently only one of several owners is listed.

GOLD (PLACER MINES).

Claude Chana is credited with the discovery of gold in Auburn Ravine (then Woods Dry Diggings) near the present town of Auburn, May 16, 1848, shortly after Marshall's discovery at Coloma. The shallow placers were often fabulously rich. Hundreds of bars along the North and Middle Forks of American River were worked, and numerous small streams in all parts of the county were highly productive. Beginning about 1857, after the surface placers were in large part exhausted, the rivers were turned from their beds, which have been thoroughly mined. Hydraulic mining began at Yankee Jim's in 1852, with a canvas hose and a small quantity of water, under a head of only about 50 feet. This camp, on the north side of Forest Hill ridge, and Michigan Bluff and Todd's Valley on the south side, were pretty well worked out by 1868. The opening of the series of buried ancient channels lying under the andesite which covers the Forest Hill divide and its northeasterly extension, followed closely on the working of the surface placers. Where the miner followed the gold-bearing gravel until it disappeared under the surface, circumstance would dictate the method of mining to be followed. Should a good supply of water be available, and the amount of overburden to be handled not seem too great in proportion to the gravel, it might first be hydraulicked and this method was also followed where the gravel was too low grade to 'drift.' But with a rich and perhaps small pay streak and with perhaps several hundred feet of overburden, often composed of volcanic material too hard to hydraulic, the only feasible method of working was to 'drift,' that is, to follow the pay streak by adits along the bedrock of the ancient stream, or in the hard bedrock below the gravel, which was extracted by means of raises, cross adits and breasts. This method of mining reached its highest development in the mines of the Forest Hill divide and the adjacent districts, notably at Sunny South and Damascus. In many claims, both hydraulic and drift mining were resorted to. Michigan Bluff, Todd's Valley, Yankee Jim's, Dutch Flat and Gold Run were pre-eminently hydraulic mining camps, while Forest Hill and Iowa Hill were known for their drift mines. Forest Hill district has been the most productive drift mining camp in the state. It was stated in 1868 that the mines within rifle-shot of the post office there had produced \$10,000,000. In 1859 this camp shipped \$100,000 of gold dust a month.

The principal placer mining districts, their estimated gold production and the production of some of the more-noted individual mines, are as follows:

Forest Hill district proper----- \$12,000,000

of which the following mines were the principal contributors prior to 1868, according to Rossiter W. Raymond:¹

Dardanelles (principally drift)-----	\$2,000,000
Mayflower -----	1,500,000
New Jersey -----	850,000
Independence -----	450,000
Deidesheimer -----	650,000

¹ Raymond, R. W. Mineral Resources of U. S. West of Rocky Mts., 1868.

Fast & Nortwood-----	\$250,000
Rough & Ready -----	250,000
Gore -----	250,000
Jenny Lind -----	1,100,000
Bath (Paragon drifting, \$1,750,000; hydraulic, \$500,- 000) -----	\$2,250,000
Todd's Valley (hydraulic mines) -----	5,000,000
Yankee Jim's, Georgia Hill (hydraulic mines)-----	5,000,000
Iowa Hill Divide (hydraulic and drift mines)-----	10,000,000
Damascus district (drift) -----	6,000,000
Hidden Treasure Mine (drift) -----	3,500,000
Michigan Bluff, Byrd's Valley (hydraulic) -----	5,000,000
Gold Run (hydraulic) -----	3,000,000
Dutch Flat (hydraulic) -----	3,000,000
Last Chance district (principally El Dorado Mine)---	2,500,000

The last large producer operated among the drift mines was the Hidden Treasure, which continued working until late in 1914. Since that time the placer gold production has come mainly from the dredgers operated along the Middle and North Forks of American River. Drift mining and gold production therefrom have been on a small scale in recent years. There has been some work near Forest Hill, Deadwood and along Duncan Canyon, the last named in the eastern part of the county in the high mountains. The keeping of definite annual statistics of gold production in California began in 1880. The figures for Placer County appear herewith. All of this except about \$3,500,000 from gold quartz mines and about \$1,000,000 from dredgers, came from placer mines. The last dredger operated in the county was being moved in June, 1927.

Geology.

The subject of geology of the auriferous gravel deposits, and especially the buried channels, has been covered in detail in the State Mining Bureau's past publications. The ancient channels of the Forest Hill and Iowa Hill divides were described in detail in the Ninth and Tenth Reports of the State Mineralogist, in articles by John Hays Hammond, Ross E. Browne and J. B. Hobson. These reports are accompanied by excellent maps, showing the geology of the districts, the location of channels, the location and extent of work done upon them at the various mines, and much other valuable information.

After seventy-five years of working such deposits, many of the drift mining districts of the county remain a baffling puzzle. In the popular mind, placer mining has always been considered simpler and calling for the exercise of far less technical skill than quartz mining. This is certainly not true as regards drift mining. In such districts as the Forest Hill divide, the drainage systems of hundreds of thousands and perhaps millions of years were finally blotted from sight by such covering of later volcanic effusions that the old topography was completely hidden. Subsequent erosion has greatly altered the face of the country, but the mantle of andesite, immense enough to conceal entire river systems, still conceals channel segments of possible value of which we know nothing.

The amazing geologic complexity of the series of stream and volcanic deposits between the bedrock of the Cretaceous and the present surface is appreciated by few.

In addition to the channels whose gravel deposits are rich enough to work profitably, there are many others which will not pay under existing circumstances. The general conditions which governed this most important feature, the gold content, are wrapped up with the geology of the ancient bedrock surface of the country over which the now buried rivers flowed, and the sequence and interrelations of the channels. They may be summarized in a few words.

The most ancient of the deposits were in the large rivers which carried on their work of erosion for probably millions of years without interruption. They accumulated in their broad beds immense amounts of debris from the erosion of the Cretaceous surface, where were exposed the earlier gold-bearing rocks. While the parts of the county principally traversed by these streams have produced no very large rich quartz mines, there are numerous gold-bearing veins and pockets and auriferous schists. The amount of rock torn down and carried off in the streams was so tremendous that much gold was collected in the stream beds. The mountains were reduced to probably one-third their original height and most of the great central valley was filled with the lighter and finer-sized fragments. Most of the rocks were so susceptible to erosive agencies that they were carried off entirely and only the more resistant, of which quartz was the commonest, remained in the higher parts of the stream courses, and gave the deposits their character of 'quartz channels.' These primary channels have been the most productive, as a whole. After their courses had been choked by the first of the volcanic outbursts, there began a period when erosion was interrupted frequently, as compared with the pre-volcanic era. The streams often did not have time to even cut their channels to bedrock before they were again choked by volcanic debris. But where they could erode deeply enough to reach the primary channel, they became rich in gold below the crossing, often richer than the original channel, as their gravel then was reconcentrated. But unless and until it made such a crossing, or reached bedrock, the later channel was apt to be disappointing to the miner. Another class of channel is the steep and narrow gulch deposit found in some of the higher districts. These resemble present-day streams in the same regions, but are covered by the later lava flows. Where present rivers removed miles of the primary channels, they in turn became rich in gold below the crossings, forming the deposits first worked by the pioneers. These streams cut trenches 2000 to 2500 feet deep, passing through the volcanic capping and eroding the bedrock formations, in which gold-bearing veins occur, to a depth of 2000 feet in places. The gold content of the primary ancient channels and of the present streams depended on the gold content of the bedrock, and the best mines were below the regions where these streams crossed the pocket and quartz veins.

There is printed herewith a directory of placer mines and prospects, giving the names, locations and ownerships of practically every placer mine in the county, together with reference by name of publication and page, to this bureau's reports describing past mining operations.

The mines of the Duncan Canyon district were described, and a map of the district published in our "Mining in California" for July, 1925. The vexed question of hydraulic mining in this and nearby counties has been discussed in detail by Arthur Jarman in the report of the California Hydraulic Mining Commission, which was reprinted in our quarterly, "Mining in California," for January, 1927. There remains to mention only the few small operations not covered in other reports cited in the directory.

Big Dipper. The last work on this old drift mine near Iowa Hill was done by A. D. Hadsel in 1920-21. Results were disappointing, and the property is idle.

Blue Eyes Prospect in Duncan Canyon was prospected for several years by Gold Dollar Mining Company, under option to purchase. The Gold Dollar adit on the Gold Dollar claim near the southwest end of the 2580 acres in this group was run 2300 feet in a direction a little west of north. This was in search of one of the steep channels, similar to that mined at the Glenn. Several bodies of gravel were opened and worked in a small way in the past on the claims now included in the Blue Eyes. The last work failed to find any payable deposit, and developed no buried channel.

After driving this adit, the company advanced the Jack Robinson adit to a length of 1300 feet on the Jack Robinson claim, three-fourths of a mile east of the Gold Dollar adit. (See map, in "Mining in California," July, 1925.) There are heavy, water-worn boulders, indicating a large channel (which is probably the Chalk Bluff channel) in the outer part of this adit, which was started years ago. It was above bedrock at the start, and, according to S. S. Caples, one of the owners, bedrock was never reached in the last work, which is reported 14 feet above the bedrock at the face. The company gave up the property early in 1927.

Boles Placer is a river claim of 100 acres about three miles upstream from Rattlesnake Bar on the Middle Fork of American River and five miles south of Auburn. This section of the river was extensively worked by damming the river and diverting the flow at the time of low water in summer and autumn through large flumes. It is believed that sections of the river on this claim were never worked out. The owners are using the same system of prospecting which was followed in 1924 and 1925.

A 40-h.p. gasoline engine and 6-inch centrifugal gravel pump and a small engine, air pump and air hose for a diver are installed on a barge which is anchored in the middle of the river by cables. An overhead cable spans the river and a hoist and engine on shore operate a steel scoop which can be lowered into the river and can be filled with coarse rock by the diver. The suction nozzle from the pump is directed by the diver, who wears the regular deep-sea outfit. Any rock small enough to pass the pump is readily handled. The pump discharges its mixed load into the head of the sluice boxes, about six feet above water level, giving ample water for washing the gravel and sufficient dump room to permit discharging tailing on the bank downstream. Work can be carried on only when the water is clear and warm enough to permit a diver to remain below several hours. Two divers alternate under

water. Some of the previous work here was done under 20 to 24 feet of water. On account of their loss in weight in water, large boulders can be handled much easier than on land.

Carmack Placer Mine, near Robertson's Flat, will be prospected this season by Mrs. George W. Carmack, Seattle. No work except assessment labor has been done for several years, but a good prospect is said to have been found last season.

Double-O Mining Company has been prospecting the old drift mines at Deadwood.

Excelsior Mine was last extensively prospected by the late Haines Gridley as trustee between 1915 and 1921. In the early days the Forest Hill channel, a front channel or bench system of the primary channel, which contributed a large part of the gold taken from the Forest

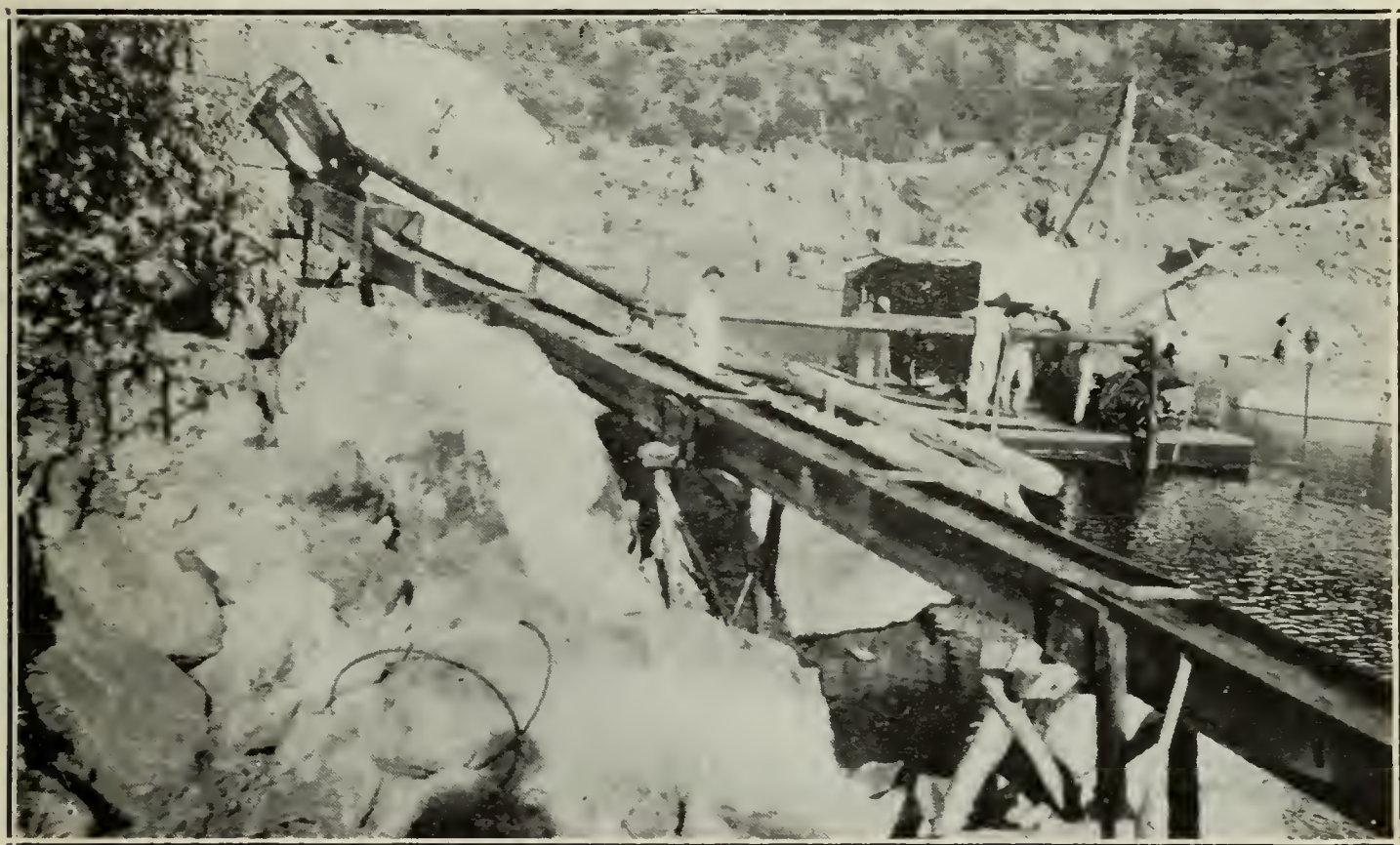


PHOTO No. 6.

Equipment used at Boles Placer Mine on American River to prospect under water. The diver worked under deep water near the point where the blocks and cable are suspended (right), directing the suction hose and loading the large boulders.

Hill district, was worked in a number of claims through tunnels entering from the south side of the ridge. This bench system or earlier and higher channel of the primary system was cut off by the later and deeper blue lead and the work in later years has been for the purpose of finding the westward extension, if any, of the earlier channel, and also to prospect upstream on the Deep Blue Lead. The latter proved to be a much wider deposit than anticipated, and in the length of channel prospected, between 400 and 500 feet upstream, did not yield gravel rich enough to pay a profit, according to Gridley. The westward extension of the earlier channel was not picked up, and Gridley's work did not reach the top of either rim of the wide channel. Some later work has been done without conclusive results. This holding includes claims

along the south front of the lava cap from the Dardanelles to the Gore, also the Excelsior, Banner and Garland Mill Slope claims. An early resumption of work is planned.

Glenn Mine, in the Duncan Canyon district, has remained almost the only producing drift mine in the county for several years. The upper workings are still mined by lessees, while F. Tillotson and associates have continued operation of the lower workings. There has been little change since the report on the mines of that region in our "Mining in California," July, 1925.

The Glenn channel is steep and narrow and the gravel is mostly of hard schist, with little quartz in it. In the lower workings on the Outlet claim the pay gravel is 12 to 15 feet wide and ranges from nothing to 2½ feet thick, being overlain by coarse volcanic sand, which in places closes directly down upon the hard, polished schist bedrock. The gold



PHOTO No. 7.

Lower tunnel, Glenn Mine.

here was mostly in the crevices of the bedrock. In the upper workings, in the Shields tunnel, the bedrock rises 140 feet in 1500 feet, there being many sheer drops of several feet, evidently waterfalls in the old channel. The Moss crevice, in this tunnel, is said to have yielded \$9,000. In flatter stretches of channel, gravel accumulated, and one body 200 feet long and up to 35 feet wide was breasted.

Georgia Hill Gravel Mine, near Yankee Jim's, was prospected in 1919 and 1920 by Georgia Hill Gold Mining Company, Inc., headed by Anthony Crafton. A tunnel 1400 feet long was run, a raise put up 206 feet and about 200 feet of drifting done. Part of the ground had been hydraulicked in early days, and the object was to prospect the channel ahead of the face of the old pit. Results were disappointing. The claims under lease in 1920 included the Buchanan, Trafton, Kerr, Armbruster, Gillespie and Adams, and 757 acres were under option.

Grey Eagle Mine, west of Forest Hill, was prospected by a subsidiary of Chief Consolidated Mining Company in 1915 and 1916. They reported a channel 50 to 80 feet wide, but that the value of gravel was not satisfactory.

Samuel Laird Ranch, east of Loomis, contains a shallow gravel deposit which was worked about 1912 by one of the most complete hydraulic elevator systems ever used in the state. Electricity was used to furnish power for pumping water. On account of the fluted granodiorite bedrock, it was difficult to deliver gravel to the elevator. About 1922 A. F. Thebo installed a drag-line bucket outfit operated by steam, but was unable to handle the ground because of insufficient power.

On the *Smyth Ranch* at Horseshoe Bar on the American River, 5½ miles east of Loomis, Mark Cameron, J. H. and C. A. Gossett and others

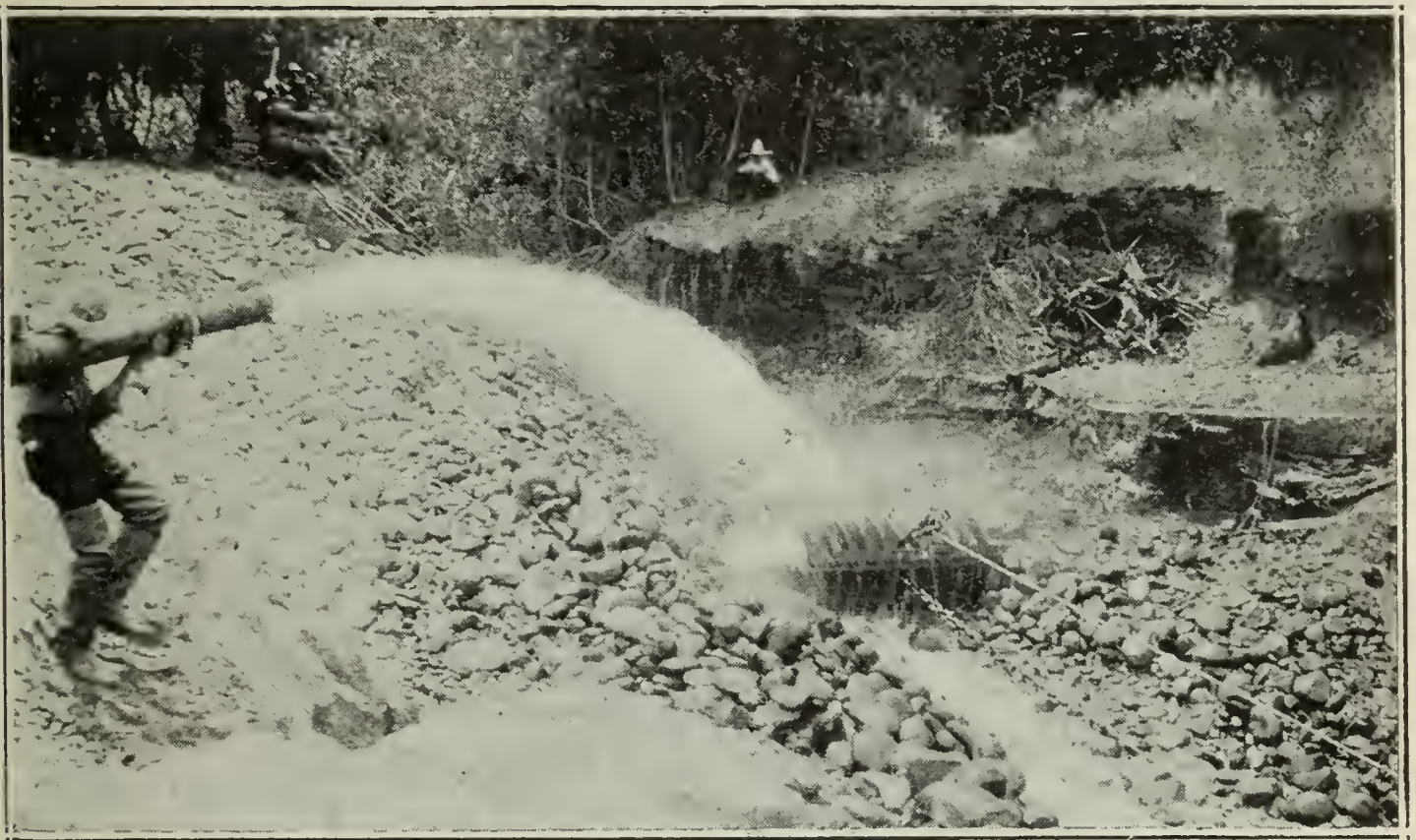


PHOTO No. 8.

New form of rake for moving boulders and cobbles, used by Cameron, Gossett and associates in placer mining at Smyth Ranch.

have just completed a test of gravel by methods illustrated in the accompanying pictures.

Water for a giant was pumped from American River with a 10-inch centrifugal pump, using a 75-h.p. tractor for power. The giant was used to pipe the gravel into a pit, from which it was drawn by an 8-inch centrifugal pump, which lifted it 25 feet into 80 feet of sluice lined with 2-inch by 3-inch iron-faced riffles. For clearing coarse cobbles from the pit, and from the gravel before reaching the pit, a specially designed rake was used. It weighs 4700 pounds, consists of 11 curved prongs of 1¼-inch by 5-inch iron spaced six inches apart, and measures about five feet wide by seven feet long. The gravel pump was operated by a 60-h.p. tractor, and another tractor of the same size operated the rake, which was fitted with a drag-line cable rig. The rake moved one-half to two-thirds cubic yard of boulders at a trip.

The operation was of interest principally because of the equipment used, as the ground worked was disappointing.

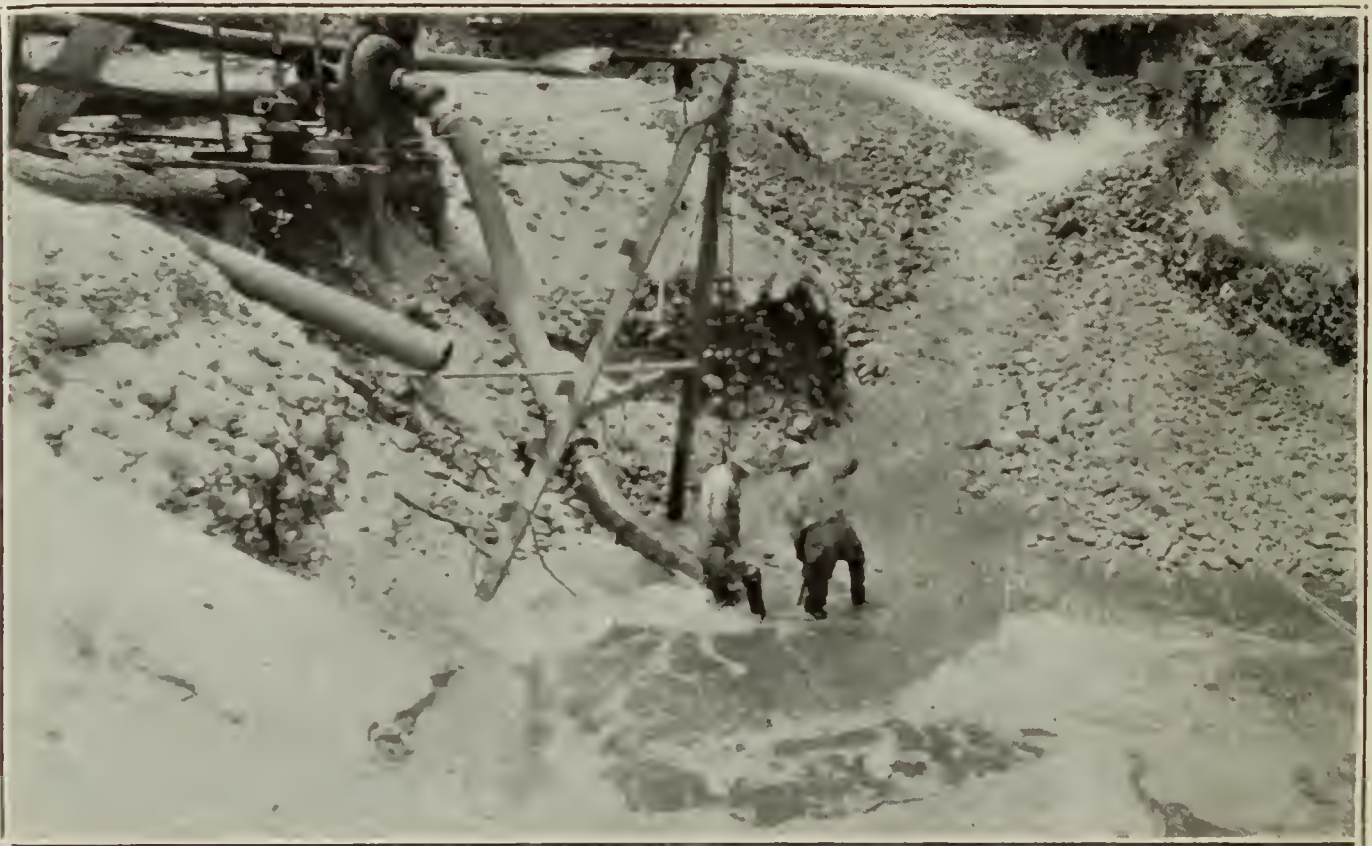


PHOTO No. 9.

Part of outfit used at Smyth Ranch for prospecting gravel.

TABLE OF PLACER MINES AND PROSPECTS, PLACER COUNTY.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Acacia	14	15 N.	11 E.	George McAulay, Auburn			R. XV, p. 379.
Alabama				Estate of P. D. Winter, 530 Twenty-second Ave., San Francisco			R. XII, p. 204; XIII, p. 272; XV, p. 352.
Allbright	36	12 N.	7 E.				R. XII, p. 204; XIII, p. 272; XV, p. 352.
Alta	36	16 N.	10 E.	Alta Gold Mining Co., 1118 Broadway, Oakland	3,380		R. XII, p. 204; XV, p. 352.
American Hill	24	15 N.	12 E.				Abandoned.
Argonaut & Sunset	22	14 N.	11 E.	C. E. Burns, Auburn	4,500		
Avalon	2	15 N.	13 E.	Attulas Mining Co., c/o C. F. Macy, Iowa Hill			
Attulas	26	15 N.	10 E.	c/o J. B. Knapp, Roseville	4,000	360	R. XIII, p. 275; XV, p. 352.
Azalea	22	16 N.	11 E.	Baker Divide Mining Co., 156 Montgomery St., San Francisco	2,838		R. VIII, p. 466; IX, p. 29; XIII, p. 273; XV, p. 352.
Baker Divide	7, 8, 9 16, 17	14 N. 14 N.	11 E. 11 E.				R. XV, p. 353.
Baker Ranch	17	14 N.	11 E.	F. B. Ellsworth, Baker Ranch	3,700		R. X, p. 426; XIII, p. 273; XV, p. 353; XXI, pp. 276-277.
Bald Mountain	21, 22 28	15 N. 15 N.	13 E. 13 E.	Ownership in dispute	5,800	160	See Excelsior.
Baltimore et al.	34, 35 34	14 N. 16 N.	10 E. 10 E.	Geo. McAulay, Auburn, et al.		2,000	
Banner				W. H. Rablin, c/o Wm. Rablin, 1405 J St., Sacramento	3,100		R. XV, p. 379.
Bartley Cons.	26	16 N.	10 E.	Estate of Wm. Rablin, 1405 J St., Sacramento	3,100	110	
Bear River	4	15 N.	10 E.	W. H. Rablin, c/o Wm. Rablin, 1405 J St., Sacramento	2,500		
Bear River	14, 23 12	15 N. 15 N.	9 E. 9 E.	Bear River Gold Mining Co., 401 J St., Sacramento			
Bear River and Texas Hill Ext.	34 21	16 N. 16 N.	10 E. 12 E.	Grace A. Gould, Fremont Ave., Mountain View			
Bear River Extension	14	15 N.	9 E.	E. C. Uren, Nevada City			
Bear River Hill, Queen City and Dutch Flat Canyon	34	16 N.	10 E.	Arthur W. Nicholls	2,000		R. XV, p. 379.
Bear River Tunnel	12	15 N.	9 E.	Mrs. Chas. Voight, 1128 Tenth St., Oakland, and Wm. Nicholls, Jr.			

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TABLE OF PLACER MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Bear River Tunnel Co.-----	6	15 N.	9 E.	} W. H. Rablin, c/o Wm. Rablin, 1405 J St., Sacra- mento----- George H. Smith, Last Chance----- Mrs. L. Bellows, Dutch Flat----- Joe Gilbert and R. C. Burry, Forest Hill-----	2,200	---	R. XV, pp. 379-380.
Belle Verne-----	5, 6, 7	15 N.	10 E.		4,800	80	R. XV, p. 353.
Belvit and American Eagle-----	26, 35	15 N.	12 N.		---	---	---
Ben Franklin-----	27	14 N.	10 E.	McGeachin Placer Gold Mining Co., Capital Nat'l Bank Bldg., Sacramento-----	2,350	160	R. XII, p. 205; XIII, p. 274; XV, p. 353. R. XV, p. 353.
Big Bar-----	20	14 N.	13 E.	} W. S. Willey, Michigan Bluff----- Estate of James Abrams, c/o A. Dixon, 2322 W St., Sacramento----- Henry Del Rey, Iowa Hill----- W. A. Freeman Estate, T. A. Nichols, Mgr., 206 Foxcroft Bldg., San Francisco-----	2,700	162	R. VIII, p. 472; X, p. 423; XII, p. 205; XIII, p. 274; XV, p. 374; XVII, p. 447; Bull. 92, pp. 135-136. R. XIII, p. 285; XV, p. 354.
Big Dipper et al.-----	3, 4	14 N.	10 E.		---	---	---
Big Gun-----	22	14 N.	11 E.		---	---	---
Biglo-----	33	15 N.	10 E.	} Blue Channel Mining Co.----- S. S. Caples and Mrs. Emma Caples, 3634 Sixth Ave., Sacramento-----	---	---	---
Birds Flat-----	13, 14	14 N.	10 E.		2,871	639	R. XIII, p. 274; XV, p. 354. See Azalea.
Black Hawk et al.-----	---	---	---		---	---	---
Blue Canyon-----	22	15 N.	10 E.	} S. S. Caples, 3634 Sixth Ave., Sacramento----- W. Fitch, E. L. Rene, Auburn, et al----- Booth River Mining Co., c/o E. Booth, Iowa Hill----- Mrs. F. A. Bowen, 601 54th St., Oakland----- Estate of Wm. Rablin, 1405 J St., Sacramento, et al-----	2,800	2,550	R. XV, p. 354; XVII, pp. 447-448; XVIII, pp. 211, 603; XIX, p. 141; XX, pp. 13-14; XXI, p. 277; Pre. Rep. 8, pp. 33-34. R. XIII, p. 275.
Blue Channel-----	32	15 N.	13 E.		---	---	R. XV, pp. 354, 380.
Blue Eyes Prospect-----	5, 7 8, 17	14 N. 14 N.	13 E. 13 E.		---	---	---
Bob Lewis-----	33	15 N.	12 E.	} Messrs. Threlkeld and Blohm, San Francisco-----	4,580	44	R. XV, p. 380.
Bogus Thunder-----	19	14 N.	13 E.		---	250	R. XIII, p. 275; XV, p. 354.
Boles-----	34	12 N.	8 E.		---	100	---
Booth River-----	29	15 N.	10 E.	---	1,300	---	---
Bowen-----	10	14 N.	11 E.	---	3,400	---	---
Bradley & Gardner-----	---	---	---	---	---	---	---
Breece & Wheeler-----	26, 35	15 N.	12 E.	} See Paragon.	---	---	---
Brooklyn and Olympia-----	36	15 N.	12 E.		4,580	235	R. XV, p. 354.

ull Run, North Fork and Bear River-----	35	16 N.	10 E.	Wm. Nicholls, Jr. et al.	-----	-----	-----
Burns-----	22	14 N.	11 E.	Michigan Bluff Mexican Cons. Mining Co., Wm. Burns, Secy., Placer County Bank, E. Auburn	3,500	200	R. XIII, p. 276; XV, p. 354.
California-Hawaiian Dev. Co.-----	-----	13 N.	12 E.	California-Hawaiian Dev. Co., 858 Mills Bldg., San Francisco	-----	4,223	See Ralston Divide Gravel.
Cambridge-----	9, 16	14 N.	10 E.	Mrs. Stemple, Colfax	-----	-----	R. XV, p. 380.
Canada Hill-----	17, 19	14 N.	10 E.	E. Armstrong, Nevada City, et al.	6,300	310	R. XV, p. 85; XVII, pp. 444-445; XVIII, p. 602; XX, p. 13.
Canyon Creek-----	20	14 N.	10 E.	Stewart Gravel Mines, Inc., c/o J. D. Stewart, Auburn	1,310	10	R. XIII, p. 276; XV, p. 380.
Canothus-----	4, 5, 9	15 N.	13 E.	James Gavin, Forest Hill	2,950	39	Field Report.
Carey-----	10	14 N.	10 E.	F. S. Bonham and Wm. A. Pelster, Iowa Hill	3,200	120	R. XV, pp. 354-355.
Carmack-----	23	15 N.	13 E.	Mrs. George W. Carmack, Seattle, Wash.	6,320	430	R. XV, pp. 368-369; XVII, pp. 448-449; XVIII, pp. 263, 603; Pre. Rep. 8, p. 34.
Cedar M.-----	4, 5	15 N.	13 E.	Martha Thomas, Towle, and John Thomas	-----	-----	R. XII, p. 206; XIII, p. 276; XV, p. 355.
Cedar Creek-----	3	15 N.	10 E.	J. L. Gould, Alameda	3,500	460	R. XV, p. 380.
Collins-----	31	15 N.	10 E.	W. B. Fowler, Colfax	-----	-----	R. XV, p. 355; XVIII, p. 211.
Copper Bottom-----	25	15 N.	10 E.	J. D. Peters, 22 San Lorenzo St., Santa Cruz	-----	-----	R. XV, p. 355.
Dam-----	23, 26	15 N.	11 E.	Damascus Mining Co., Monadnock Bldg., San Francisco	3,715	174	R. XV, p. 355.
Damascus-----	14, 15	15 N.	11 E.	Hidden Treasure Mining Co.	3,748	1,548	R. VIII, p. 469; IX, p. 29, 120; X, p. 451; XII, p. 209; XIII, pp. 277, 281; XV, p. 355.
Dardanelles Cons.-----	23	15 N.	11 E.	T. L. Chamberlain, Auburn	2,600	312	R. VIII, p. 464; IX, p. 29; X, p. 465; XII, p. 207; XIII, p. 277; XV, p. 355; Bull. 92, p. 136.
Dayton-----	2	13 N.	10 E.	M. E. Poor, Iowa Hill	-----	10	R. XIII, p. 282; XV, p. 355.
Devil's Basin-----	27	15 N.	10 E.	R. Lofruth, Deadwood; J. E. Ferguson, Michigan Bluff. Under option to Double-O Mining Co.	3,700	-----	XV, p. 356.
Devil's Gate-----	1	14 N.	11 E.	Chas. Pinoli, Forest Hill	-----	137	R. XV, pp. 356-357.
Dewey Cons.-----	25	14 N.	10 E.	Joseph Scherer and John Franks, Last Chance; A. Morehead	-----	-----	R. XV, p. 357; XXI, pp. 277-278; Pre. Rep. 8, p. 34.
Dixie Queen-----	33, 34	15 N.	10 E.	Doulbe-O Mining Co., H. R. Staples, Pres., P. O. Box 734, Oxnard	4,000	240	Pre. Rep. 8, p. 34.
Double-O Mining Co.-----	9, 16	14 N.	13 E.	-----	-----	573	Pre. Rep. 8, p. 34.
Double-O Mining Co.-----	31, 32	15 N.	12 E.	-----	-----	-----	-----

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TABLE OF PLACER MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Dow	33	14 N.	10 E.	Mary Dow Stevens, 555 Bush St., San Francisco, et al.			
Dutch Flat Blue Lead	3	15 N.	10 E.	C. S. Jordan, Dutch Flat, and J. L. Gould, 16 Ensloe Ave., Alameda		80	R. XV, p. 357.
Dutch Flat Canyon	34	16 N.	10 E.	Mrs. H. L. Beal, 123 Terminal St., San Jose			R. XV, p. 357.
Dycr	35	16 N.	10 E.	Lewis A. Gould, Fremont Ave., Mountain View	2,800	20	R. XV, p. 357.
Eagle Bar				Win. Duff, Forest Hill			See Pacific Gold Gravel.
El Dorado	31, 32	16 N.	11 E.	R. Monroe, Dutch Flat, et al.			R. XIII, p. 278; XV, p. 357
Elite	25	15 N.	9 E.	Eric Mining Co., c/o J. W. Morgan's Estate, Auburn	3,950	425	
Estey							See Rocky Bar.
Eureka Cons. Drift Mining Co.	8, 9	15 N.	12 E.	Eureka Cons. Drift Mining Co., 519 California St., San Francisco			
	10, 17	15 N.	12 E.				
	18, 19	15 N.	12 E.				
	20, 24	15 N.	12 E.		4,400	2,342	R. XIII, p. 278; XV, p. 357.
	25	15 N.	12 E.				R. XV, pp. 357-358.
Excelsior	34	16 N.	10 E.	George McAulay, Auburn, et al.			
Federal Drift				Federal Drift Mining Co., W. T. Watson, Supt., Dutch Flat, Dr. W. B. Coffey, Pres.			
Fernier	16, 18	13 N.	10 E.	R. R. Read, 812 Broadway, Oakland	3,000	125	R. XV, p. 358.
Fitzpatrick	32	15 N.	10 E.	M. E. Poor, Iowa Hill		240	
Florida & Tilton	25	14 N.	10 E.	A. Jones, 1615 Fifteenth Ave., Seattle, Wash.	3,550	109	R. XV, p. 359.
Flying Fish	34	16 N.	10 E.	John C. and Ed. Uren, 1016 N St., Sacramento	3,100	15	R. XV, p. 359.
Forest Hill Mining Corp.	15, 16 et al.	14 N.	11 E.	Forest Hill Mining Corp., Box 734, Oxnard, lessee, with option, of Muir Cons.			
Foss							See Maguire.
Franklin	10	14 N.	11 E.	Geo. V. Nicholls, 2647 24th St., San Francisco	3,400		R. XIII, p. 278; XV, p. 359.
General Grant	33, 34	15 N.	10 E.	S. M. Sprague, 418 Twenty-fifth St., Sacramento, 2/3; Ben Rossi, Jr., 527 Twenty-eight St., Sac- ramento, 1/3			
Georgia Cons.	9, 10	14 N.	11 E.	D. M. Burns, 614 Crocker Bldg., San Francisco, et al.			
Georgia Hill Gravel Mining Co., Inc.	32, 33	14 N.	10 E.	Georgia Hill Gravel Mining Co., Inc., 297 Thayer Bldg., Oakland, J. F. Posert, Gen. Mgr.	2,450	757	XVIII, p. 211; Pre. Rept. 8, p. 34.

Gillett	31	15 N.	10 E.	F. N. Gillett, Colfax			R. XV, p. 380.	
Gleason	9, 10	14 N.	10 E.	Mrs. M. Gleason, Iowa Hill	2,692		R. XV, p. 359.	
Glenn Cons.	22, 27	15 N.	13 E.	} Glenn Cons. Mining Co., George McAulay, A. K. Robinson, Auburn, et al.	5,000	660	R. XIII, p. 278; XV, pp. 359-360; XVII, p. 449; XVIII, pp. 7, 603; XX, p. 13; XXI, p. 278; Pre. Rep. 8, pp. 34-35; Bull. 92, p. 140.	
	28, 34	15 N.	13 E.					
Golden Dipper				Golden Dipper Placer Mining Co., 232 Fairgreen Ave., Youngstown, Ohio				
Golden Gate	22	15 N.	13 E.	L. & A. Borchart, 2413 I St., Sacramento				
Gold Dollar							See Blue Eyes.	
Golden Channel	1	16 N.	11 E.	J. W. Hyatt, Emigrant Gap	4,800	480	R. XV, p. 360.	
Golden Gem et al.	15	14 N.	11 E.	A. K. Robinson, Auburn				
Golden Nugget	12	16 N.	11 E.	C. M. Everhart, Gold Run	4,000	640	R. XV, p. 360.	
Golden River	12, 13	15 N.	11 E.	} J. A. Ferguson, Forest Hill, agent for Societe des Mines de Golden River, Paris, France				
	14, 23	15 N.	11 E.					
	15	15 N.	11 E.					
	3, 4, 5	15 N.	12 E.			3,827		R. VIII, pp. 470-472; IX, p. 29; X, p. 456; XII, p. 208; XIII, p. 279; XV, p. 360.
	6, 7, 8	15 N.	12 E.					
Golden Shaft	18	15 N.	12 E.	} Golden Star Mining Co., c/o N. E. Booth, Colfax	3,175	9	R. XIII, p. 279.	
	35	16 N.	10 E.			140		R. XV, p. 360.
	24	15 N.	10 E.					
	35	15 N.	10 E.					
Golden West	4, 5	15 N.	13 E.	Golden West Cons. Mining Co., Grass Valley	6,500	400	R. XV, p. 360.	
Gold Ring	1	15 N.	10 E.	Mr. West, Towle	1,500	63	R. XV, p. 361.	
Gorman et al.	27	14 N.	11 E.	A. A. Gorman, Michigan Bluff		250	R. XIII, p. 279; XV, p. 360.	
Gould	23	15 N.	10 E.	Gould Placer Mining Co., c/o D. S. Steanberger, San Diego			R. XV, p. 361.	
Gould Group	33, 34	16 N.	10 E.	} Lewis A. Gould, Fremont Ave., Mountain View	2,200			
	3	15 N.	10 E.					
	23	16 N.	11 E.					
	5, 6, 7	15 N.	16 E.					
Great Channel							See Hermit.	
Greek	1	15 N.	12 E.	Martin Burner, Forest Hill, et al.			R. XVII, p. 449; Pre. Rep. 8, p. 35.	
Grey Eagle	5, 6	13 N.	10 E.	Amelia C. Coughlin, Dutch Flat	2,400		R. XIII, pp. 279-280; XV, p. 361.	
Grizzly Canyon et al.	10	14 N.	10 E.	Chauncey H. Dunn, Sacramento		176		
Haney Cons.	4	14 N.	13 E.	Thomas F. Haney, Last Chance			R. XV, pp. 380-381.	
	33	15 N.	13 E.					

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TABLE OF PLACER MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Hard Climb-----	3, 9	14 N.	13 E.	Estate of McCullough Brothers, Michigan Bar, and Charles Hilton, c/o Glen Mine, Last Chance-----	4,000	400	R. XV, pp. 361-362; XXI, pp. 278- 279; Pre. Rep. 8, p. 35. See Big Dipper.
Harmon-----	21, 28 20, 21 28 3 26, 27 34, 35	12 N.	8 E.	Haskell Gold Mining Co., c/o Ed. Gaylord, Auburn, et al.-----	1,200	180	Field Report.
Haskell-----		14 N.	11 E.	Hazard Gravel Mining Co., M. E. McGeoghegan	3,720	222	R. XIII, p. 280; XV, p. 362.
Hazard-----		16 N.	11 E.	Robert Watson, Blue Canyon-----	3,400	33	R. XIII, p. 280; XV, p. 362.
Haub-----		14 N.	11 E.	Mrs. Bowen & Sons, Michigan Bluff-----			
Hermit-----		15 N.	11 E.	Hidden Treasure Mining Co., Harold T. Power, Secy., 625 Call Bldg., San Francisco-----	3,644	1,545	R. VIII, p. 469; IX, pp. 29, 120; X, p. 451; XII, pp. 209-210; XIII, p. 281; XV, p. 362; Bull. 92, p. 137.
Hidden Treasure-----	34, 35	15 N.	11 E.				
Hogsback-----	2, 3	15 N.	12 E.	Compagnie des Mines et Minerals, 26 Rue de Chateaudon, Paris, France; J. A. Ferguson, agent, Forest Hill-----	4,525	1,545	R. VIII, p. 472; XIII, p. 281; XV, p. 363.
Homestake-----	31	14 N.	11 E.	M. Savage, Forest Hill-----	1,260		R. XV, p. 363.
Home Ticket-----	26, 35	15 N.	12 E.	J. F. Thompson, Bath, or Box 178, Long Beach, et al.-----	4,700		R. XV, p. 363; XVIII, p. 211; Pre. Rep. 8, p. 35.
Hoose, Garden Claim, You Bet and Brown-----	33, 34	16 N.	10 E.	George V. Nicholls et al.-----			
Horseshoe Bar et al.-----	4	13 N.	11 E.	Horseshoe Bar Cons. Mining Co.-----		62	R. IX, p. 277; XIII, p. 281; XV, p. 382.
Iowa Hill and Byrds Flat-----	34	15 N.	10 E.	Mrs. J. McPherson, 1051 S. Flower St., Los Angeles-----			
Iowa Hill-----	26, 27	14 N.	10 E.	Wm. Muir, Oakland-----			
Indian Hill-----	9, 10	15 N.	10 E.	J. L. Sparhawk, Iowa Hill-----			R. XV, p. 363.
Irish & Byrne-----	3, 4	14 N.	10 E.	McGeachin Placer Gold Mining Co., Capital National Bank Bldg., Sacramento-----			
Jack Robinson-----	16	14 N.	13 E.	S. S. Caples, 3634 Sixth Ave., Sacramento-----	4,070		R. XV, p. 363.
Jarvis-----	14, 15	15 N.	11 E.	H. M. Jarvis, Mobile, Ala.-----	3,850	160	R. XV, p. 363.

Jupiter Cons.	11	14 N.	10 E.	McGeachin Placer Gold Mining Co., Capital Natl. Bank Bldg., Sacramento	250	R. XV, p. 363.
Kelly	9	11 N.	8 E.	M. A. Kelly, Auburn		R. XV, p. 382.
Kinder River	28	15 N.	10 E.	Estate of T. L. Schwab, Iowa Hill		R. XV, p. 382.
Ladies Canyon				W. F. Ford, Forest Hill, c/o George S. Ford		
Laird River Claim				Sam Laird, Loomis		
Lebanon	3	14 N.	10 E.	Lebanon Mining Co., 404 Twenty-eighth St., Oakland; J. E. Walsh, Auburn	2,928	Field Report.
Lehigh	30	14 N.	11 E.	J. F. Thompson, Bath		R. XV, p. 382.
Bob Lewis				St. Clair	2,680	See Jarvis.
Live Oak	22	14 N.	10 E.	E. T. Robie, Auburn; George F. Miller, Blue Canyon, et al.		R. XIII, p. 282; See Devil's Basin.
Lofruth	23	16 N.	11 E.		4,500	R. XIII, p. 282; XVII, p. 451; XV, p. 364.
Lost Camp						
Lucky George	16	14 N.	13 E.	M. Savage, 1242 Polk St., San Francisco	40	
Macedon	1	15 N.	12 E.	Kate F. Johnson, 2411 Hillside Ave., Berkeley; Mrs. Agnes Snyder, Forest Hill, et al.	5,000	R. XV, p. 364; XVII, p. 449; Pre. Rep. 8, p. 35.
Mad Canyon, New York Bar, Apache				Marsh Lowell, Auburn		
Maguire				Mr. and Mrs. Wm. Maguire, Nevada City		R. XV, p. 364.
Manhattan-Michigan	15, 16	14 N.	11 E.	A. K. Robinson, Auburn		
Mammoth Bar				Howard Davis, Auburn, et al.		
Marian	35	14 N.	11 E.	Estate of E. A. Hill, Michigan Bluff	3,800	R. IX, p. 280; X, p. 417; XII, p. 210; XIII, p. 282.
Mars Cons.	31	16 N.	12 E.	Sam Wolford, Grass Valley		R. XV, p. 364.
Martin	31	15 N.	10 E.	F. P. Gallaher, Colfax		
Mascot	26	14 N.	10 E.	See Baltimore or Excelsior	20	R. XV, p. 382.
Masonic	27	15 N.	10 E.	Masonic Mining Co., c/o Alice McIntosh, Roseville		R. XV, pp. 357-358; (Excelsior) XVII, p. 449-450.
Maus	36	14 N.	10 E.	W. H. Craig, Forest Hill	3,000	
Mayflower	22, 23 24, 25 26	14 N. 14 N. 14 N.	10 E. 10 E. 10 E.	Mayflower Gravel Mining Co., Room 1210, 995 Market St., San Francisco	2,700	R. VIII, p. 467; IX, pp. 29, 120; X, p. 453; XII, pp. 210-211; XIII, p. 283; XV, pp. 94-95; Bull. 92, p. 137.
McGeachin Placer Gold Mining Co.	3, 4	14 N.	10 E.	McGeachin Placer Gold Mining Co., Capital Natl. Bank Bldg., Sacramento	2,500	Includes Morning Star et al. See Burns.
McManus River	9, 10	14 N.	10 E.		1,600	

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Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Missouri-----	33, 34	14 N.	10 E.	N. E. Booth, Colfax-----	2,650	-----	R. XV, p. 365.
Mohawk-----	26	15 N.	10 E.	Peter F. Hinst, E. W. Smith and A. A. Bissell, Westville-----	3,200	-----	R. XV, p. 365.
Monumental-----	5	15 N.	13 E.	Mr. Moody, Pacific Hardware Co., San Francisco	5,300	200	R. XIII, p. 283; XV, pp. 365-366.
Moody Ridge-----	3, 10	15 N.	10 E.		3,650	120	R. VIII, p. 472; IX, p. 29; X, p. 240; XII, p. 211; XIII, p. 283; XV, p. 366.
Morning Star-----	33, 34	15 N.	10 E.	McGeachin Placer Gold Mining Co., Capital Natl. Bank Bldg., Sacramento-----	2,700	163	R. VIII, pp. 472-473; IX, p. 29; X, p. 420; XII, p. 211; XIII, p. 283; XV, p. 366; XVIII, p. 45. R. XV, p. 366.
Mountain Chief-----	34	14 N.	11 E.	Fred Outhouse, Forest Hill-----	-----	-----	-----
Mountain Tunnel-----	4	13 N.	10 E.	A. C. Bequette, Auburn-----	-----	220	-----
Mountain Lilly-----				Estate of P. G. Ekberg, Auburn-----	-----	-----	-----
Muir Tunnel Cons.-----	15, 16	14 N.	11 E.	See Forest Hill Mining Corp.-----	-----	469	-----
New Baccarat-----	23	12 N.	6 E.		-----	160	R. XIII, p. 283-284; XV, p. 366.
New Basil Cons.-----	2, 3	15 N.	12 E.	R. F. McLeod, 350 California St., San Francisco	4,900	380	R. XV, p. 368.
New York et al.-----	10, 11	15 N.	12 E.	T. L. Schwab, Iowa Hill, et al.-----	-----	64	-----
North American-----	9	14 N.	10 E.	L. K. Devey and Brother, Blue Canyon-----	-----	-----	R. XV, p. 368.
North Bell-----	28, 29	16 N.	11 E.	E. DeKrusc; R. F. Cannon, Iowa Hill-----	-----	-----	-----
North Fork and Bear River, Bear River Tunnel and 1,000 Ft. Claim-----	22	15 N.	10 E.		2,500	-----	-----
	4, 5	15 N.	10 E.	Estate of Wm. Rablin, 1405 J St., Sacramento;			
	33	16 N.	10 E.	Mrs. Eliz. Uren, Apple River, Ill.; Lewis A. Gould, Fremont Ave., Mountain View and Butte Eng. & Electric Co.-----			
North Star et al.-----				North Star Mining Co., 404 Twenty-eighth St., Oakland-----			
Occidental-----	3	14 N.	10 E.	Occidental Mining Co., c/o C. E. Macy, Iowa Hill; J. E. Wretman, Garden City Bank Bldg., San Jose-----			
Orion & Rule-----	32	15 N.	10 E.	Estate of C. F. Macy, Iowa Hill-----	3,300	171	R. XV, p. 368.
Oro-----	10	14 N.	11 E.	A. Dixon, Michigan Bluff-----	3,500	-----	R. XIII, p. 284; XV, p. 368.

Oro-----	14, 23	15 N.	10 E.	Oro and Mountain View Cons. Mining Co., c/o W. H. Russell, Colfax	-----	221	R. XV, p. 368.
Outhouse Cons.-----	24	15 N.	11 E.	Outhouse Cons. Mining Co., Fred Outhouse, Forest Hill, Pres.	-----	960	See Carmack Placer Mines.
Pacific Blue Lead-----	26	15 N.	12 E.	Placer Gold Gravel Co., Michigan Bluff	-----	160	R. XV, p. 371.
Pacific Gold Gravel-----	27, 28	15 N.	12 E.	Pacific Slab Cons. Mining Co., M. C. Threlkeld, Pres., 1007 Monadnock Bldg., San Francisco	4,700	512	R. XV, pp. 346-347; 370-371.
Pacific Slab-----	33, 34	15 N.	12 E.	J. F. Thompson, Box 178, Long Beach, or Bath	-----	500	R. VIII, pp. 467-468; IX, p. 29; X, p. 455; XII, p. 206; XIII, p. 275; XV, pp. 347; 370-371; Bull. 92, pp. 136-137.
Paragon, Breece & Wheeler-----	19, 24 30	14 N. 14 N.	11 E. 11 E.		2,900		R. XV, p. 377.
Park & Brown-----	21	15 N.	13 E.	C. D. McKinley, Auburn, et al.	-----	160	R. XV, p. 371.
Pear Tree and Necessity-----	2	13 N.	9 E.	C. M. Langstaff, M. Savage, Forest Hill	-----		See Gold Ring.
Penn Valley-----	27	15 N.	10 E.	Mrs. B. F. Jamieson, 415 Third St., San Rafael	3,200	120	R. XV, p. 382.
Pennsylvania-----	3	14 N.	10 E.	E. E. Freeman, Rose Nicholls, 206 Foxcroft Bldg., San Francisco; J. E. Walsh, Auburn	-----		R. XV, p. 371.
J. D. Peter's-----					-----		
Pine Avenue-----					-----		
Pioneer Slope-----	25	14 N.	10 E.	W. H. Craig, Forest Hill	-----		
Placer Queen-----				Placer Queen Gold Mining Co.	6,230		
Pleasant Bar-----	33	14 N.	11 E.	E. Kavanaugh, 40 J St., Sacramento	-----		R. XV, p. 371.
Potato Flatiron-----					-----		R. XV, p. 382.
Polar Star, Little Bear R. and Southern Cross-----	34	16 N.	10 E.	Geo. V. Nicholls, 2647 Twenty-fourth St., San Francisco, et al.	-----		R. XV, p. 383.
Polar Star-----	34, 25	10 N.	10 E.	Wm. Nicholls, Jr., Berkeley	3,100	70	R. XV, p. 373.
Poverty Bar-----				Charles A. Fowler, 2129 I St., Sacramento	-----		R. XV, p. 379.
Protection-----	34	15 N. 13 N.	13 E. 12 E.	Glenn Cons. Mining Co.	-----	100	
Ralston Divide Gravel-----	15 different sections	14 N. 13 N. 14 N.	12 E. 13 E. 13 E.	California & Hawaiian Dev. Co., J. S. McCandless, Pres., 858 Mills Bldg., San Francisco	3,500	4,223	R. XV, pp. 371-372; XVII, p. 450-451; Pre. Rep. 8, p. 36.
Red Point-----					-----		See Golden River.
Red Star-----				D. M. Ray, Last Chance, and M. Savage	-----		R. XV, p. 372; XXI, p. 280.
Reed-----	8	15 N.	13 E.	Mr. J. D. Meredith, Capital National Bank Bldg. Sacramento	6,000	150	R. XV, p. 372.
Robinson Flat, Screw Auger-----				W. S. Edwards	-----		
Rocky Bar-----	1	14 N.	9 E.	O. L. Estey, Colfax	1,050		R. XV, p. 383.
Rough and Ready-----	35, 36	14 N.	10 E.	Emma Williams, 3018 Encinal Ave., Alameda; G. H. Garrison, 715 I St., Sacramento, et al.	-----		R. XV, p. 372.

*Due to various legal complications which may arise regarding ownership of unpatented mining claims, we do not vouch for absolute correctness of this column. The names are mostly those appearing on the tax rolls. To save space, frequently only one of several owners is listed.

TABLE OF PLACER MINES AND PROSPECTS, PLACER COUNTY—Continued.

Name of mine	Location			Last owner's or operator's name, address*	Eleva- tion, feet	Area, acres	Bibliography
	Sec.	Twp.	Range				
Sacramento	34	16 N.	13 E.	Sailor Canyon Gravel Mining Co., W. H. Duffy, Supt., San Francisco			R. XVIII, p. 263.
Sam Laird				Sam Laird, Loomis			R. XIII, p. 285; XV, p. 372.
Santa Fe				Morgan Green & Co., Auburn			R. XIX, pp. 140-141.
San Francisco	4	14 N.	10 E.	S. Delmu, Iowa Hill		10	R. XV, p. 372.
Schlettman				Mrs. J. P. Just, 1209 E St., Sacramento			R. XV, p. 383.
Sellier							See Outhouse.
Shackleton				Estate of Shaw Brothers			See Shell Mine.
Shaw Brothers'				Perry and A. V. Shell, Blue Canyon			R. XIII, p. 285; XV, p. 372.
Shell				John and Wm. Watts			R. XV, p. 372.
Strawberry	23, 26	15 N.	10 E.			211	
Winfred Shirley, Willow Bar and American Bar	4, 5	13 N.	11 E.	John A. Britton, 445 Sutter St., San Francisco			
Small Hope	27	14 N.	10 E.	Mr. Federer and James Nicholson, Sacramento		40	R. XII, p. 212; XIII, p. 285; XV, p. 373.
Smyth Ranch				Mrs. Sam Laird, Loomis, et al.			
Southern Cross	34, 35	10 N.	10 E.	Geo. V. Nicholls, 2647 Twenty-fourth St., San Francisco	3,000	40	R. XIII, p. 285; XV, p. 373.
Spring Garden	5, 6 7, 8	13 N. 13 N.	10 E. 10 E.	N. W. Nash, Sterling		530	R. XV, p. 373.
St. George	33	14 N.	10 E.	A. M. Colwell, Yankee Jim, Mgr.			
Star United	27	15 N.	10 E.	H. Gosch, 111 Conway Ave., Grass Valley; Ben Rossi, Iowa Hill, et al.	2,700		R. XIII, p. 286; XV, p. 373.
Starr	26	15 N.	12 E.	L. C. Hines, Mgr., Westville			
Stewart	9	15 N.	10 E.	Stewart Gravel Mining Co., Mrs. G. A. Stewart, Pres., J. D. Stewart, Secy., Auburn	4,800		R. XV, p. 373.
Succor Flat	24, 36	15 N.	10 E.		3,000		R. XV, pp. 373-374.
Swamp Angel	7, 10	16 N.	11 E.	A. W. Hawkins, San Luis Obispo			R. X, pp. 420, 422; XVIII, p. 211.
Swift Shore	34, 35	15 N.	11 E.				R. XV, p. 384.
	2, 3	14 N.	11 E.	J. S. Vieckford, Michigan Bluff			
Tagpole Cons.	6	15 N.	13 E.	J. L. Sparhawk, Iowa Hill		280	R. XV, p. 374.
Theniss & Adams	1	14 N.	9 E.	Martin Theniss and P. C. Adams, Colfax	1,200		R. XV, p. 384.

Truro	21, 22	15 N.	10 E.	Truro Placer Mining Co., c/o G. C. Hepburn, Applegate	1,650	106	R. XIII, p. 266; XV, p. 374.
Turkey Hill Consolidated	9, 10 15, 16	14 N. 15 N.	11 E. 11 E.	Turkey Hill Cons. Gravel Co., c/o Wm. Muir & Son, Michigan Bluff			R. X, p. 441; XII, p. 213; XIII, p. 286; XV, p. 374.
Twenty-One	3, 10	14 N.	10 E.	O. F. Goodum			
Union	28	15 N.	10 E.	Wm. Hales & Son, Will Hales, 3400 Forty-third St., Sacramento	2,900		R. XV, p. 374.
Unison	35	16 N.	10 E.	J. H. Runckel, Dutch Flat		9	
Veteran	5	15 N.	12 E.	Golden Fleece Gravel Mining Co., 822 Foxcroft Bldg., San Francisco			
	3	15 N.	12 E.			640	
	34	16 N.	12 E.				
Volcano	15	14 N.	11 E.	Wm. Muir, Michigan Bluff			R. XV, p. 374.
Waterhouse							See Big Dipper; X, p. 423; XV, p. 374.
Watts Prospect	26	15 N.	10 E.	John Watts, Colfax			R. XIII, p. 286; XV, p. 374.
Welcome				Est. of T. L. Schwab, Iowa Hill		200	R. XV, p. 375.
Weske							See Turkey Hill Cons., R. X, p. 441; XII, p. 213; XIII, p. 286.
White Pine	27	15 N.	10 E.	Mrs. E. Entwisle, Roseville, et al.			
Wild Yankee				F. K. Develey, Blue Canyon	3,800		R. XIII, p. 286; XV, p. 375.
Willey, Batchelor, Bigelow, Wills	21	14 N.	11 E.	Mrs. Mary Dixon, 2322 W St., Sacramento Estate of Mavis Wills, c/o J. A. Wills, Michigan Bluff			
Wisconsin							See Dyer.
Wolverine	27	15 N.	10 E.	E. S. Davis, 615 Twenty-ninth St., Sacramento, et al.			
X-Ray				F. Stevens, San Francisco		38	
Yule & Willey, A. & E., Franklin				Alfred Dixon, 2322 W St., Sacramento		320	R. XV, p. 375.
Zelma Bell	19	14 N.	10 E.	Zelma Bell Mining Co.		40	R. XV, p. 384.

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GRANITE.

Granodiorite, locally called granite, is the principal rock outcropping in the district between Rocklin and Newcastle. Quarries were opened at Penryn by G. Griffith and at Rocklin in 1863 and 1864 immediately after the completion of the Central Pacific Railroad to those points. Many of the finest buildings in the state, including the state capitol and a number in old San Francisco, were built with the Placer County stone. The industry at these two towns employed 300 men or more until 1890, when the demands of stonecutters for increased wages and the competition of manufactured building materials strangled it.

There are several grades of stone in the different quarries. That from Rocklin is a rather fine-grained biotite granite with considerable orthoclase, and the dark minerals are not prominent, so that the color is silver gray. At Penryn the stone in the main quarry is formed of much coarser crystals and biotite and hornblende are prominent. That at Loomis is intermediate in character between the two. A mile east of Penryn, a small quarry was opened on an outcrop of gabbro, a black medium-grained stone used for small work. All of these stones take a high polish. There is an abundance of granite more remote than the above quarries, and small workings have been opened at several places near Lincoln, Loomis and elsewhere. Granodiorite also occurs in the extreme northern part of the county in the vicinity of Emigrant Gap. Elsewhere than named above, the outcrops of this stone in the county are too remote from the railroad to be commercially available.

Most of the quarry workings were in pits, which in several cases have reached a depth of 100 feet. The stone is for the most part remarkably straight grained. It was broken out with plugs and feathers and hoisted from the pits with derricks operated by steam. Polishing works using steam power were operated at Penryn and Rocklin. Stone was supplied for a great variety of uses, including buildings, cemetery work, curbing, railroad culverts and rip-rap. The last large order for building stone was filled in 1920 by California Granite Company, which supplied stone from its Rocklin quarry for the Bank of Italy Building, San Francisco. The business has dwindled until at present only a few men are employed at Rocklin in getting out an occasional small order, and none of the other quarries have been active for years. The Rocklin and Penryn quarries were served by spur tracks from the main Central Pacific line.

Adolph Pernu and Sons work the quarry formerly operated by California Granite Company. It is in the town of Rocklin. During the past two years only a small amount of monumental stone has been quarried. The property is supplied with electric power and compressed air.

Oscar Anderson has a quarry in the town of Rocklin from which he fills occasional orders for rip-rap, curbing, etc. Part of this work is sometimes sublet to other quarrymen.

None of the other quarries have been active the past two years. In all, 27 quarries at Rocklin were listed in the Fifteenth Report of the State Mineralogist, 1915. Most of them employed only two to four men each.

Griffith Quarry at Penryn has been idle practically ever since 1890, when its founder, G. Griffith, died. The buildings and equipment are falling in ruins.

IRON.

Hotaling Iron Mine. John Barnicott, Newcastle, owner. It is $3\frac{1}{2}$ miles west of Clipper Gap by road, in Sec. 15, T. 13 N., R. 8 E.

The deposit consisted of magnetite and hematite lenses at the contact of granodiorite, diabase and Carboniferous limestone and slate. It was found in 1866 and was worked until 1885, but principally between 1880 and 1885. The ore contained from 40% to 65% iron.

High-grade hematite was mined from No. 1 shaft and open cut. This orebody was 250 feet deep, 30 feet wide and 100 to 150 feet long, and was 100 yards south of the old furnace site. It is reported worked out. No. 2 shaft was in magnetite of lower grade. It was 150 feet deep and an orebody 50 feet wide by 150 feet long was mined. The high-grade hematite from No. 1 was mixed with the lower grade magnetite from No. 2 to give furnace feed containing an average of 55% iron. The stopes were timbered with square sets. No. 4 shaft was 100 feet deep and produced some iron.

According to J. Richards, who was superintendent of the property during the principal operations, the blast furnace was operated steadily between 1880 and 1885, except for three months time lost in rebuilding it after a fire. Oak wood was cut from 25,000 acres of land in the vicinity for charcoal. Limestone was mined on the property. From 30 to 35 tons of fine quality pig iron was produced daily. It was used by the Southern Pacific Company for car wheels and axles, and by other coast industries. Competition from Alabama iron and depletion of the high-grade ore, hastened closing. Considerable lower grade ore is believed to remain.

Other properties in the district nearby furnished small tonnages of low or medium-grade ore, which was hauled to the Hotaling furnace and mixed with the high-grade hematite for smelting.

Iron ore croppings occur in Sec. 21, T. 14, N., R. 9 E., near Weimar, and were prospected many years ago by Phoenix Iron and Lime Company.

PLACER CO.

LIMESTONE.

A series of deposits of limestone of good grade occur at intervals, from Middle Fork of American River, five miles east of Auburn, northward. A small body of white granular limestone at the old Hotaling iron mine, $3\frac{1}{2}$ miles west of Clipper Gap, was used for flux during the smelting operations. Another deposit, $2\frac{1}{2}$ miles south of west of Clipper Gap on the South Fork of Dry Creek, and one on the east side of the town of Auburn, have also been worked. Another series of limestone lenses outcrop at intervals from the Middle Fork of American River in the vicinity of Mammoth Bar, seven miles east of Auburn, to the vicinity of Applegate. Most of these are too small for cement plants, but some have supplied lime for other purposes. There are two large deposits in the canyon of American River, one five miles from Auburn on the Forest Hill road on the Middle Fork, and the other below Gorge station on the North Fork. Other deposits in the more remote parts of the county are too far from the railroad to be commercially valuable now.

De Witt Deposit. Owner, Mrs. Eleanor De Witt, 1931 C street, Sacramento, California. This is a small deposit of good quality limestone, $1\frac{1}{4}$ miles by road south of Clipper Gap.

Dunlap Deposit. Owner, Boutwell Dunlap, Auburn, California. A large lens of gray limestone, outcropping for a mile in length, has been traversed by the Middle Fork of American River. The southern portion, in El Dorado County, has supplied an immense tonnage for cement manufacture, having been operated for many years by Pacific Portland Cement Company. The Dunlap property is the part in Placer County which is crossed by the Forest Hill road five miles from Auburn. The outcrop rises to a height of nearly 500 feet above the river level, is one-third mile long and several hundred feet wide. No work has been done upon it.

Vic Mathews, Lincoln, has offered for sale a deposit of limestone six miles from the railroad.

E. Petterson, Box 46, R. F. D., Lincoln, California, has a deposit of good grade limestone on the main line of the Southern Pacific one mile from Auburn. The deposit outcrops for a length of about 1000 feet and width of 100 feet. Some of it has been burned for lime.

Spreckels Deposit. Owner, Spreckels Sugar Company, Spreckels, California. Contains one patented mineral claim, a millsite and other land adjoining, 102 acres in all, in Secs. 8 and 9, T. 13 N., R. 9 E., one mile by road from Applegate station.

The deposit is of fine-grained, bluish-grey limestone of good quality. It is from 100 to 200 feet wide, 20 to over 100 feet deep and 650 feet long, according to logs of drill holes, some of which showed serpentine and slate interbedded with the limestone. It lies below the surface and would have to be worked by a pit. The last operations were by the owners in 1916.

Sullivan and Linder Deposit. Owners, D. J. Sullivan, Alta, and Mrs. R. E. Linder, 2022 Brush street, Oakland.

This is a large, undeveloped deposit in the canyon of North Fork of American River below Gorge station, on the road to the Rawhide Mine. Probably one-half mile of tramway would be required to deliver the limestone to the railroad.

MAGNESITE.

Small magnesite prospects occur near Damascus, Michigan Bluff, Gold Run and north and south of Towle. A little work was done 11 years ago and one property was a small producer in 1916 and 1917, since which time all these prospects have been idle. The following brief notes are extracts from our Bulletin 79, "Magnesite in California," 1925, pp. 59-60, and from our Report XV, 1915, pp. 391-392.

Little Bear prospect is in SE $\frac{1}{4}$ Sec. 35, T. 16 N., R. 10 E., above Alta power house. A 2 $\frac{1}{2}$ -foot vein was exposed, but not enough ore was found to make a shipment.

Placer County Properties Company's claims of 400 acres were in Sec. 13, T. 15 N., R. 10 E., and Secs. 7 and 18, T. 15 N., R. 11 E., five to six

miles northeast of Iowa Hill. The Colfax-Iowa Hill road, now being rebuilt in part (1927), will give a haul of 13 to 14 miles from these claims to Colfax if grades are reduced enough to permit trucking. Otherwise there would be a 30-mile haul via Foresthill.

Small magnesite outcrops occur, and a stockwerk of magnesite veins up to eight inches wide was cut in an old adit.

Sullivan Claim is on 80 acres in N $\frac{1}{2}$, Sec. 19, T. 16 N., R. 11 E., four miles by road from Alta. A 4-foot vein was followed for 50 feet in an adit, where it broke into narrower veins. An incline was also run 70 feet on stringers of magnesite. Forty tons of magnesite were shipped in 1916, and a little in 1917. D. J. Sullivan, Towle, and others, owners.

Outcrops of magnesite, undeveloped, are reported in Sec. 6, T. 15 N., R. 11 E., north of Towle, and in Secs. 24 and 36, T. 16 N., R. 10 E., south of Towle.

MANGANESE.

Some prospects of manganese oxide were opened in 1917-18 nine miles from Colfax, adjacent to the road leading to Yankee Jim's and Forest Hill, in Secs. 20 and 29, T. 14 N., R. 10 E.

The ore occurred near the surface as black oxides in quartz lenses striking N. 50° W. At a depth of only a few feet the ore began to show rhodonite, which was increasing with depth. The country rock is of the Calaveras formation.

Gray Lease was on land belonging to the Central Pacific Railway Company in Sec. 29, T. 14 N., R. 10 E. The showing of manganese ore here was only slightly prospected.

Tilsey & Copen group of four unpatented claims were located in January, 1918, in Sec. 20, T. 14 N., R. 10 E., and were worked in a small way during that year. About two carloads of black manganese oxide ore was mined. Idle since 1918.

Bibl: Calif. State Min. Bur. Bull. 76, pp. 52-53.

D. W. Lee of Yankee Jim's has a manganese oxide prospect near that place.

MARBLE.

Holmes Lime and Cement Company, 2 Pine street, San Francisco, owner. Dark gray marble with jet black and white veining occurs on property owned by this company in the NW $\frac{1}{4}$ of NW $\frac{1}{4}$ of Sec. 4, T. 14 N., R. 9 E., 3 $\frac{1}{2}$ miles west of Colfax, on the south bank of Bear River. There is a good road to a point on the hill 1000 feet from the quarry, from which point a tramway, now in ruins, extended down the steep slope to the workings.

A face 40 feet high by 400 feet long has been opened. Some of the marble was sawed and used in the early days in the United States Mint and Bank of California in San Francisco, and in other buildings. Later the stone was burned to make lime, but the quarry has been idle for ten years, and the two old circular iron kilns are in poor condition.

MINERAL PAINT AND FILLER.

Low-grade iron oxide in the form of red and yellow ocher has been shipped from the *Bancroft Ranch* and other properties in the vicinity

of the Hotaling Iron Mine, in the Clipper Gap district. There has been no production for two years past. This oxide was used for paint.

Some low-grade yellow ocher or iron-stained shale has been shipped from the *Everhart Brothers* property, two miles from Gold Run. While the exact use to which it was put is not known, it is believed to have been used for filler, mortar color or some similar purpose. There has been no production for three or four years.

Some dark reddish-brown ocher, evidently decomposed iron oxide sand, was shipped in 1924 from the vicinity of Sugar Pine mill, nearly 25 miles by road from Colfax via Forest Hill. It was reported to have been used for paint.

PLATINUM GROUP METALS.

These metals have been recovered as a by-product of gold dredging on the forks of American River. Two dredgers were operated on the Middle Fork, one near Mammoth Bar and the other about three miles farther upstream, between 1914 and 1918. From 1918 until the middle of 1927 one of these was operated on the North Fork, beginning three miles above the junction with the Middle Fork. The production of the above metals compared favorably with that from other districts, but amounted in all to only a few ounces a year, as the yardage handled here was relatively small. The assay of the product showed a content of iridium about equal to that of platinum, with traces of palladium and rhodium.

Although the American River drains large areas of serpentine and allied rocks, from which rocks the platinum group metals have no doubt been derived, there have never been any discoveries of these metals in place in the county. The most interesting belt of serpentine and peridotite extends from the Middle Fork of American River at Volcano Canyon, southeast of Forest Hill in a northerly direction through Towle to Bear River, being covered at intervals by the later andesite.

Bibl: Cal. State Min. Bur. Bull. 85, pp. 29-30.

ROCK, SAND AND GRAVEL.

Enwood Sand and Rock Company's plant is just east of Roseville on the state highway and is served by spur track from Southern Pacific railroad. Scott F. Ennis and Edward S. Brown, owners, Sacramento.

Sand and gravel are taken from Secret Ravine. The sand is coarser than that from many pits and is preferred for certain uses. Digging is done with a P. & H. drag-line outfit, and the material is hauled over a narrow-gauge railroad in 3-yard side-dump cars by gasoline locomotive to a 24-inch belt conveyor, which raises it to the top of the plant. The first or scalping screen separates the sand and fine gravel up to a 2-inch size. Sand is washed after passing this screen. Coarse rock passes to primary and secondary crushers and is again elevated, screened through two conical screens and the various sizes of crushed rock are distributed to separate bunkers. From these, the rock is drawn to a 20-inch mixing belt for loading in railroad cars or truck bins or for delivering to

another conveyor which takes it to the outside stock piles. A clam-shell bucket is used to load cars from the stock piles.

A little gold is recovered when the sand is washed.

J. A. Robles, Applegate, has a large deposit of silica sand along Bear River, $4\frac{1}{2}$ miles by road west of Applegate. The deposit is about 200 feet wide and up to 7 feet deep, occurring in bars at intervals along the river for two miles. So far, it has been used only locally for concrete.

The granite quarries at Rocklin are in a position to supply rock in large sizes for riprap, breakwaters, railroad fills and the like. Contracts for such rock are filled occasionally.

Mariposite suitable for roofing rock or stucco dash occurs at the Four Aces quartz mine in Volcano Canyon, three miles from Forest Hill and 18 miles by road from Colfax, the nearest railroad point.

SILICA (VEIN QUARTZ, COBBLES, SAND).

A wide ledge of pure white quartz outcrops on the *Davenport* property in the canyon of American River about one mile from Auburn (Railroad St. station). It could be cheaply mined because of its width and the slope of the hill. It adjoins the Pacific Portland Cement Company's private railroad from Mountain Quarries to Flint, on the Southern Pacific west-bound main line a mile west of Auburn, but this private road is said to not be a common carrier. M. E. Davenport, Auburn, owner.

Quartz cobbles have been shipped from Gorge by *Dan Sullivan*, Alta. They were gathered from the bedrock of an ancient channel, where they were left after hydraulicking.

Quartz cobbles and boulders have also been shipped for many years from the *Polar Star* hydraulic mine and other claims at Dutch Flat. W. P. Nicholls, Jr., Berkeley, owner. Both of these localities are within a short distance of the railroad and the quartz was loaded and delivered to the cars at a very low cost, as there was practically no mining expense involved, except the occasional breaking of a large boulder. Most of the recent sales have been to rolling mills and for use in making fire brick.

Silica sand has been prospected in Sec. 8, T. 11 N., R. 7 E., between Rocklin and Loomis and between the two lines of the Southern Pacific; also in Secs. 9 and 10, T. 12 N., R. 6 E., adjacent to Gladding, McBean and Company's works.

SOAPSTONE AND TALC.

Wall Property. Owners, Wall heirs, care Wall Brothers, Gold Run. Leased to K. W. Keasbey, Colfax. It is on patented land in the NE $\frac{1}{4}$ Sec. 23, T. 15 N., R. 9 E., $3\frac{1}{2}$ miles north of Colfax, adjacent to the You Bet road.

The deposit is a large upright lens of talc and block soapstone on a ridge above the road. It was worked quite extensively over 30 years ago by open pit. Selected blocks were lowered down the 45° slope on a cable car and sawed to size for engine fire bricks and similar uses. The largest pit was 200 feet long by 50 feet wide by 30 feet deep, showing soap-

stone and talc the entire distance; it was proven at least 200 feet farther on the strike and is 10 to 20 feet wide. The dip is vertical. The material is soft and without grit. Most of that exposed in the open pit is slightly iron stained. There is reported to be a workable vein of high quality white-grinding talc in an old tunnel, which was inaccessible at the time of visit. Keasbey has been doing some prospecting to develop this.

An analysis of the talc by Abbot A. Hanks follows:

Silica -----	60.04%
Ferrous oxide -----	3.48
Aluminum oxide -----	1.14
Magnesium oxide -----	28.89
Calcium oxide -----	0.00
Ignition loss -----	4.3
Undetermined -----	2.15
	<hr/>
	100.00%

ZINC.

Zinc has never been produced commercially in the county, but under favorable conditions may be at some time in the future.

Valley View Mine, six miles northeast of Lincoln in SE $\frac{1}{4}$ Sec. 13, and NE $\frac{1}{4}$ Sec. 24, T. 13 N., R. 6 E., was originally worked as a gold mine, but later developed into a copper property. Three shafts, 130, 180 and 280 feet deep, have been sunk on the property. Zinc sulphide occurs in association with the copper sulphide in some of the ore. Judge J. B. Landis and Ed. Gaylord, Auburn, are the owners.

The present price of zinc hardly warrants the hope of making zinc producers of the small, high-cost California mines, though this may occur whenever the price improves and the metallurgical art advances to the point where a clean zinc sulphide concentrate can be made from Californian ores at reasonable cost. The only large zinc producer in the state, in Shasta County, has closed down during August, 1927, because unable at present to make a profit.

ZIRCONIUM.

Zirconium, in the form of zircon, the silicate, occurs in small amount as a primary constituent of the granodiorite which forms so large a part of the country rock east of the Sacramento Valley. In places where sand has accumulated from erosion of the granodiorite, zircon is found as part of the heavy concentrate. So far as known, no real work has been done to determine the feasibility of recovering it.

LOS ANGELES FIELD DIVISION.

W. BURLING TUCKER, MINING ENGINEER.

LOS ANGELES COUNTY.

Los Angeles County is bounded on the north by Kern County, on the east by San Bernardino County, on the south by Orange County, on the west by Ventura County and the Pacific Ocean.

The ocean shore line extends for about ninety miles. The county comprises four thousand and sixty-seven square miles, or about three million five hundred and eighty-four thousand acres, a large proportion of which is mountainous.

Physiography.

The chief topographic features of this county are the mountain ranges, the valleys and the great Los Angeles Plain which stretches from the foothills to the sea.

The principal mountain range is the San Gabriel, which extends with a northwest trend 45 miles from Cajon Pass to Soledad Canyon. The two principal peaks of this range are Mount Lowe (elevation 5650 feet) and Mount Wilson (elevation 5700 feet). The latter is the site of an astronomical observatory. The other prominent peaks of this range are Mount San Gabriel, elevation 6152 feet, and Mount Markham, elevation 5760 feet. The main portion of this range lies north of San Gabriel River, and contains all the highest peaks of the range, as Mount San Antonio (Old Baldy), elevation 10,080 feet and about 4 miles west of Mount San Antonio, Iron Mountain, 7517 feet high. About 6 miles southwest is Mount Gleason, elevation 6503, and about 20 miles northwest is North Baldy, 9389 feet high. Other ranges in the county are the Santa Susana and Santa Monica. The former, which is a continuation of the San Gabriel Range, lies north of San Fernando Valley, and the Santa Monica Range flanks the coast, extending from the ocean in Ventura County eastward to the Los Angeles River. The San Gabriel Range is chiefly formed of crystalline rocks, with its central axis consisting of granite, with gneisses and schists on its flanks. The Santa Susana and Santa Monica ranges are chiefly formed of Tertiary sedimentary rocks.

Los Angeles County has two principal rivers, San Gabriel and the Los Angeles. San Gabriel River takes its source in the San Gabriel Range and flows southwest, reaching the ocean through Alamitos Bay. Los Angeles River rises in the Santa Monica Mountains near the Ventura County line and, flowing thence through San Fernando Valley, east and south, unites near Compton with the Rio Hondo, its waters emptying into Long Beach Harbor.

Mineral Resources.

There is only a small production of metals in Los Angeles County, its principal wealth being in structural and industrial materials, petroleum and natural gas.

The production of petroleum for the year 1926 amounted to 105,826,337 barrels, valued at \$174,084,324, while the production of natural gas was 91,054,793 M cu. ft., valued at \$8,965,307.

Among its mineral resources may be noted asphalt, barytes, borax, brick, clay, copper, fuller's earth, gems, gold, gypsum, infusorial earth, lead, limestone, marble, mineral paint, mineral water, natural gas, petroleum, glass sand, sandstone, serpentine, silver, soapstone, miscellaneous stone and zinc.

METALS.

ANTIMONY.

This metal occurs associated with complex sulphide ores carrying copper, cobalt, nickel, lead and zinc in Pacoima Canyon, on the claims formerly held by the Denver Mining and Milling Company, of San Fernando. It occurs as stibnite, antimony sulphide. It is also reported to occur near Lancaster.

Bibl: State Mineralogist's Report XVII, p. 318; State Mining Bureau Bull. 38, p. 359.

CHROMITE.

Chromic iron ore occurs as float in the vicinity of Acton, Bouquet Canyon and Harold, a station on the Southern Pacific Railroad.

Acton Chromite Deposit is located in T. 5 N., R. 13 W., S. B. M., not far from the railroad station at Acton. The occurrence is not of commercial importance.

Bibl: State Mineralogist's Report XV, p. 471.

Bouquet Canyon Deposits. Considerable high grade chromite has been found over the surface near the summit of the ridge north of Bouquet Canyon, 13 miles north of Saugus, a station on the Southern Pacific Railroad.

The chromite is found as float, varying in size from two inches in diameter to large boulders of 100 pounds in weight in a zone of serpentinized peridotite, that strikes northeast. The harder serpentine contains a small amount of chromite disseminated through it. To date no lens of ore has been found in place. The ore is reported to carry 42% Cr_2O_3 . A number of claims were located along the serpentine belt during 1918 and considerable prospecting was done in this area, but no commercial tonnage was developed.

Evert Chromite Deposit. The deposit is located one mile west of Harold, a station on the Southern Pacific Railroad.

Bibl: State Mineralogist's Report XV, p. 471.

COBALT.

Occurrence of cobalt has been noted in several localities in Los Angeles County, but to date no commercial production has resulted. It occurs in Pacoima Canyon in deposits of complex ores, carrying antimony, copper, nickel, lead and zinc; also in the Kelsey mine (see under Lead-Silver), in the Silver Mountain District.

COPPER.

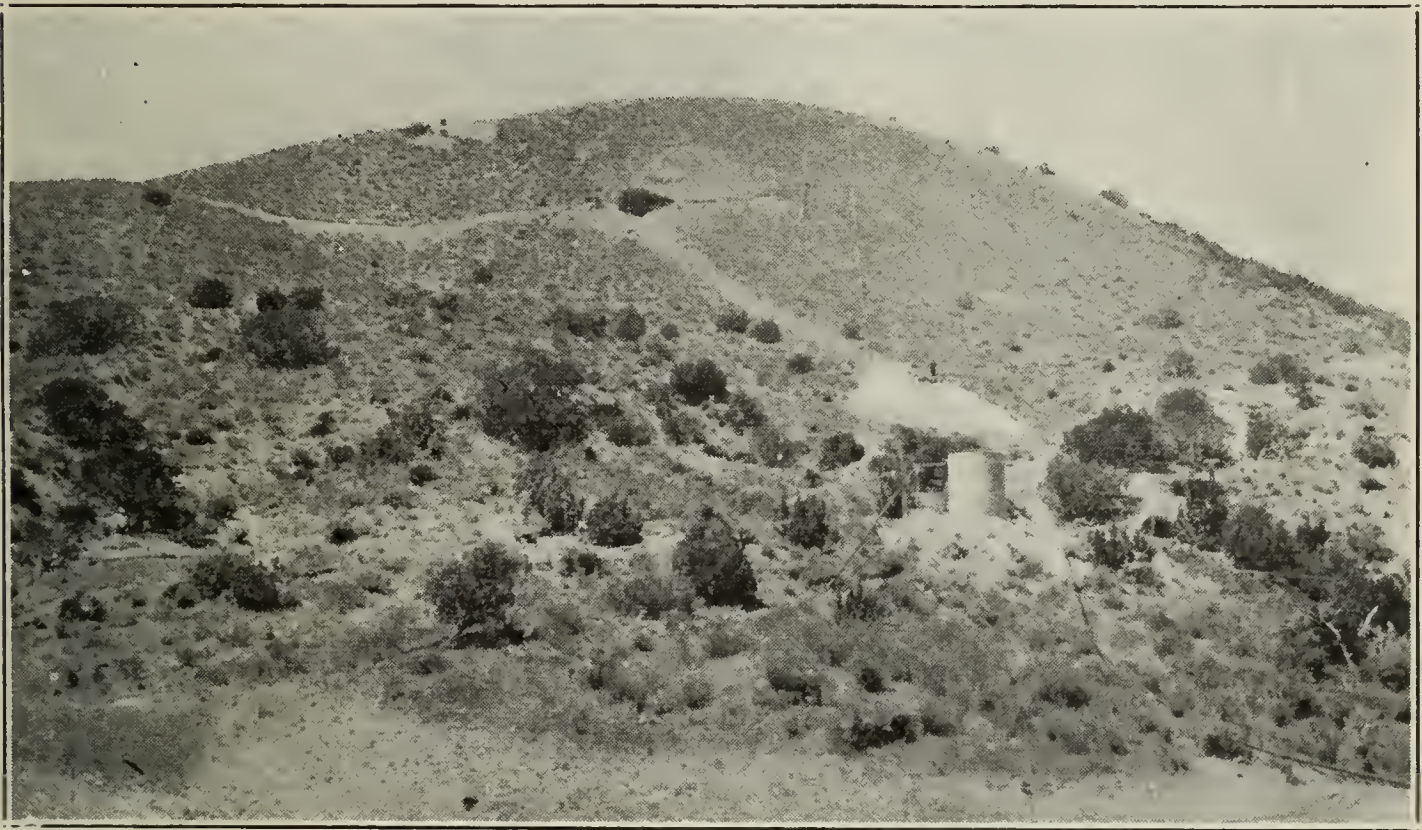
There are no producing copper mines in the county, but copper ores occur near Acton, at Black Mountain, east of Palmdale and on Santa

LOS ANGELES COUNTY—MINERAL PRODUCTION 1880-1926.

Year	Gold	Silver	Petroleum		Asphalt (tons)	Natural gas (M cu. ft.)	Gypsum		Salt		Gems, Value	Mineral water		Brick		Pottery clay		Sandstone and serpentine		Miscel- laneous stone, Value	Miscellaneous and unapportioned				
			Barrels	Value	Amount	Value	Tons	Value	Tons	Value		Gallons	Value	M	Value	Tons	Value	Cubic feet	Value		Amount	Value	Substance		
1880	\$7,700	\$66,300																							
1881	13,000	39,000																							
1882	17,000	24,000																							
1883	20,000	25,000																							
1884	40,000	11,000																							
1885	22,500	1,945																							
1886	21,500	6,750																							
1887	25,000	25,000																							
1888	20,000	10,000																							
1889	38,203	97																							
1890	74,320	7,266																							
1891	40,759																								
1892	219,204																								
1893	14,200																								
1894	34,500		475,650	\$617,065			1,134	\$11,340						7,500	\$37,500					\$5,500	9,500 bbls.	\$10,800	Lime.		
1895	23,330		979,695	732,817			3,790	37,820						45,800	235,000					47,500					
1896	35,468		953,734	812,800			960	9,180						27,478	179,290			71,500	\$6,000	30,000					
1897	40,698		1,327,011	1,327,011			1,900	17,250						36,868	228,290			72,500	2,500	30,625	5 tons	200	Infusorial earth.		
1898	21,300		1,462,871	1,462,871			2,500	18,500						25,908	188,386	50	\$500	10,500	5,250	32,500	2 tons	50	Sulphur.		
1899	13,132		1,409,356	1,409,356	*1,151	\$23,020	3,563	14,250				193,500	\$5,805	23,385	147,400			*6,000	3,000	112,001	1,600 cu. ft.	2,000	Marble.		
1900	5,508		1,722,887	1,722,887	*5,000	100,000	2,500	10,000						55,725	275,925	4,576	10,776	*7,500	3,750	24,352					
																		*350	2,000						
																		*89	90		10 tons	19	Soapstone.		
1901	10,312		2,304,432	1,062,038	*10,000	*1,500	3,500	35,500	6,650	\$19,950				44,435	264,825	130	390			04,229					
1902	7,209		2,198,496	1,075,868	*16,767	171,904			90	180				52,776	335,670	890	890			105,047	100 tons	300	Mineral paint.		
																					14,400 lbs.	504	Lead.		
1903	8,674	22	1,960,604	1,294,866	*28,308	332,600	5,914	38,441	8,000	20,000		95,000	5,500	79,105	706,334	115	115	*2,163	9,734	118,185	60 tons	360	Infusorial earth.		
																					1,736 tons	2,558	Glass sand.		
																					219 tons	10,124	Soapstone.		
1904	12,402	73	2,190,000	1,289,910	*30,425	307,068			7,560	24,480		125,750	7,084	128,719	767,827	5,000	5,000	*29,211	13,145	83,826	10,000 bbls.	10,000	Lime.		
																		*200	2,310		709 tons	4,254	Glass sand.		
1905	15,035	100	2,854,564	1,056,188	*23,718	119,430	11,500	43,500	12,000	20,000		175,000	31,250	109,563	853,810	30,533	16,066	*8,784	9,950	69,021	228 tons	2,315	Soapstone.		
1906			2,814,000	908,800	*25,920	259,200	21,000	69,000	12,000	36,000		85,465	5,128	127,965	826,831	41,350	34,350	*19,080	9,540	176,558					
																		*847	1,694		18,000 bbls.	18,000	Lime.		
1907			4,318,739	2,633,541	*26,610	353,423	7,500	50,000	12,000	36,000		385,000	35,100	101,079	895,272	17,500	20,500	*21,196	19,076	36,904	50 tons	200	Infusorial earth.		
																		*1,000	3,000		849 lbs.	169	Copper.		
1908			6,244,347	4,082,052	*25,000	250,000	12,000	75,000	12,000	48,000	\$8,500	573,975	42,857	108,414	800,163	25,934	55,274	*6,202	2,000	598,618	1,000 cu. ft.	3,000	Marble.		
																					25,000 bbls.	25,000	Lime.		
1909	864	2	5,400,392	3,513,192	*40,740	516,500	10,000	50,000	10,000	30,000	9,500	266,315	19,088	136,202	1,195,892	14,027	26,688			182,377	200 tons	8,000	Glass sand.		
																					1,800 tons	14,400	Glass sand.		
																					2,000 cu. ft.	6,000	Marble.		
																					842,530		Unapportioned, 1900-1909.		
1910			5,127,266	3,185,433	*45,872	591,193			6,000	12,000	4,900	319,491	23,999	148,723	1,361,653	450	800			324,091	40 tons	320	Infusorial earth.		
					*30,920	15,208															60 tons	720	Feldspar.		
																					80 tons	200	Glass sand.		
1911			4,924,288	3,313,972		*15,208			7,592	16,113	5,000	229,019	17,256	160,259	1,442,913	15,650	41,025			553,076	1,600 cu. ft.	4,800	Marble.		
1912			4,484,590	2,798,384		*78,672			10,360	46,370	3,000	76,495	6,333	174,862	1,692,258	11,929	12,028			955,668	1,100 cu. ft.	3,300	Marble.		
1913	2,322	27	4,143,690	2,672,680	*1,287,704	77,578			10,000	40,000	2,500	255,095	15,140	204,912	1,752,106	7,425	20,135			1,008,810	1,800 tons	1,800	Glass sand.		
																					1,800 tons	2,000	Glass sand.		
1914			3,558,690	1,957,279	*1,250,000	75,000			20,000	60,000	2,100	331,151	8,025	133,557	1,244,971	8,263	14,566			953,434	240,000		Other minerals.		
1915			2,931,098	1,843,661	*1,729,035	120,783					700	350,171	29,491	88,669	820,312	6,507	1,511			1,022,134	13,203 tons	349,669	Borax.		
																					10 tons	460	Potash.		
1916			2,875,468	1,871,930	*2,083,664	139,522					600	320,700	8,552	82,005	760,912	6,233	10,549			971,153	1,864 tons	324,769	Barite, borax, potash.		
																					612 tons	1,684	Potash.		
																							373,374	Borax, copper, graphite, salt.	
1917			4,669,583	5,491,430	*1,670,476	194,793					300	188,368	16,902	and tile	939,081	6,276	10,321			608,026	1,710 tons	400,902	Potash.		
																							542,768	Borax, graphite, magnesium chloride, salt silica, serpentine, tale.	
1918			10,125,190	13,567,755	*2,088,959	224,279						110,481	15,540	43,381	668,676	12,634	11,820			547,190	18,630 tons	121,903	Building tile.		
																						2,380 tons	462,600	Potash.	
1919			15,076,633	20,805,754	*4,148,476	458,812						125,400	8,787	and tile	1,185,154	11,329	33,343			715,524			386,865	Borax, gems, graphite, magnesium chloride, manganese, salt, serpentine.	
																							399,007	Borax, gems, graphite, magnesium salts, manganese, salt.	
1920			14,026,536	21,488,653	*6,225,835	556,465			6,502	6,577		161,466	10,371	127,854	2,333,941	18,684	91,763			1,704,951	27,954 tons	308,476	Building tile.		
																							473,966	Borax, copper, gold, graphite, infusorial earth, lead, magnesium salts, silver.	
1921			12,395,605	25,795,254	*6,944,277	638,936						264,468	13,314	and tile	3,208,448	29,055	62,866			1,763,180			222,943	Borax, gems, gold, graphite, limestone, mag- nesium chloride, salt, silver.	
1922			37,726,367	52,930,093	*23,254,549	1,653,571						300,400	15,450		240,424	4,190,485	54,024	66,519			3,390,477	39,095 tons	397,136	Building tile.	
																						12,096 tons	35,168	Limestone.	
																							72,772	Borates, gold, graphite, magnesium salts, salt, silver.	
1923	714	6	158,665,019	154,063,733	*134,799,452	8,760,961						440,563	24,787	310,897	5,307,968	128,825	59,272			5,408,808	53,199 tons	522,890	Building stone.		
																						2,717 tons	8,779	Building tile.	
																							169,541	Limestone marl.	
1924	751	5,515	119,027,428	147,474,953	*122,838,521	9,191,395						1,889,285	88,942	301,957	5,030,259	84,065	132,855			5,923,329			46,941 tons	454,728	Building tile (hollow).

Catalina Island. Copper also occurs as chalcopyrite in the complex ores of Pacoima Canyon. Exploration and development on the deposits near Acton were attempted in 1889 and the Black Mountain deposits were prospected in 1908, but no commercial production was made. The only active development in recent years is on the deposits located near Acton, which was started in 1926, by Allen Mines Company, of Los Angeles.

Black Mountain Deposits. These deposits are located 27 miles southeast of Lancaster on Black Mountain. The ore occurs as malachite and carries values in gold and silver. There is a series of parallel veins in gneiss that strike northwest. Widths vary from 12 inches to 2 feet. A number of shafts have been sunk on the different vein showings to depths of 10 to 15 feet. The ore is reported to carry from 2% to 7% copper with from \$3 to \$7 in gold and silver. Eight claims are owned by J. L. Watts, of Lancaster, California.



Surface workings of copper veins, Parker Mountain Mine, Acton, California.

A copper deposit formerly worked by the Palm Development Company in 1908 is located in Sec. 30, T. 5 N., R. 10 W., S. B. B. and M., 12 miles southeast of Palmdale. The ore occurred in a porphyritic dike, which averaged 180 feet in width. The dike is mineralized with malachite and carries values in gold and silver.

Bibl: State Mineralogist's Report XV, p. 471.

Denver Mining and Milling Company. W. S. McGrew, W. B. Folger, National Bank Building, San Fernando, California, own a group of claims known as Denver, Chance, Fenner, Indicator and Red Ledge, 12 miles northeast of San Fernando, in Pacoima Canyon. Elevation 2610 feet.

There is a series of parallel quartz veins that occur in schist and gneiss and strike N. 80° E. and dip 60 to 80° south. The veins vary in width from 2 to 4 feet, with the exception of the Red Ledge vein which in places is 20 to 50 feet wide. The ore is a complex sulphide, carrying

massive pyrrhotite, chalcopyrite, galena and sphalerite and stated to carry traces of nickel, cobalt and antimony.

These sulphides occur in lenticular masses in the different quartz veins. Development consists of a number of shafts and tunnels on the different veins. Idle.

Bibl: State Mineralogist's Report XVII, p. 318.

King of West Mine. It is located one mile south of Acton, just north of Southern Pacific Railroad tracks. Holdings comprise 80 acres of patented land. Owner, R. E. Nickel, of Acton, California.

A vein of quartz 4 feet in width occurs in granite. It strikes north and has a vertical dip. The quartz is mineralized with malachite, bornite and carries values in gold and silver.

Development consists of a shaft sunk on the vein to a vertical depth of 150 feet and a number of other shallow shafts. Idle.

Parker Mountain Mine. (Emma Group of Mines.) The property comprises 100 acres of patented land and 5 claims held by location, located 2 miles south of Acton. Owner, Highland Mining Syndicate, William B. Conover, agent, Bradbury Building, Los Angeles. Under option to Allen Mines Company—Walter B. Allen, president; R. E. Ashworth, secretary; E. D. Foster, general manager.

In 1889 this group of copper claims was worked by the Emma Consolidated Mining Company. The present company started operations in 1926 and is planning to leach the ore for the recovery of its copper content. Elevation 2200–2900 feet.

The deposit consists of a series of parallel veins that strike northeast and dip slightly to the east, containing copper in quartz. There is also a series of parallel quartz veins that strike east and dip north about 50° that cross the northeast veins. The different veins vary in width from 3 to 20 feet. The country rock is granite. In the neighborhood of these veins there are a number of diorite intrusions which strike east and dip south. The ore is copper carbonates, bornite and chalcopyrite, in quartz gangue. The average value is stated to be 2% copper with values in silver and gold of \$1.20 per ton. The veins that have been developed to any extent are known as the Emma, Bullion, Pacific and London.

Development: The Emma vein has an average width of four feet and strikes northeast. A shaft has been sunk to a depth of 75 feet and at an elevation of 2800 feet a crosscut tunnel has been driven in the granite N. 60° W., 458 feet, to intersect the vein. The present development work is confined to this vein, where at an elevation of 2900 feet, an opencut has been made on the vein on the south slope of the hill. About 50 feet above this opencut is a diorite dike 20 feet in width that strikes east and dips south. The ore is being mined from this opencut by means of a dragline scraper, which delivers it to ore pocket, from which it is trammed over incline tram in cars having a capacity of 2 tons, to stock pile for leaching. The ground storage capacity of stock pile is stated to be three-quarters of a million tons. The ore is reported to have an average value of 1% copper. The ore is to be heap leached with a 2% H_2SO_4 solution. Solution from ore pile flows through wooden troughs to 7000-gallon settling tank. Overflow from settling tank goes to seven precipitation launders where air is used for agitation.

It is stated that the plant will recover one ton of copper precipitate per 24 hours.

The Bullion vein runs parallel to the Emma vein and dips toward it. This vein has a width of 8 feet. The ore carries copper with silver and gold values. The Pacific is an extension of the Bullion vein. The London vein crosses the other two veins. The Pacific has a shaft 40 feet deep, exposing 6 feet of quartz, that is mineralized with copper carbonates and chalcopyrite. The London vein has a width of 3 feet. On this vein there is an incline shaft 75 feet deep and a crosscut tunnel one hundred feet in length, driven to cut the vein at a depth of 300 feet. The ores are carbonates and sulphides in quartz. About one-quarter of a mile northeast of opencut on north slope of the hill, an opencut exposes a vein 25 feet wide that strikes northeast and which forms a bold outcrop on the surface which can be followed on its strike to the top of the mountain. The quartz is mineralized with copper carbonates, bornite and chalcopyrite. Samples taken across 20 feet are reported to assay 2% copper with \$1.50 in gold and silver. Equipment consists of 7½" x 6" Chicago pneumatic compressor driven by Manx truck motor; 15-h.p. Pioneer hoist for dragline scraper; ore bins; two 2-ton cars. Six men are employed.

Bibl: State Mineralogist's Report XV, p. 472.

Santa Catalina Island Copper Deposits. The occurrence of copper is reported by Preston in Report X of the State Mineralogist, on the south side of Cherry Valley Harbor in a vein that strikes north and has a width of 4 feet. The vein is mineralized with copper sulphides and galena.

GOLD.

Gold was first discovered in Los Angeles County in 1834 and the placers of San Francisquito, Placerita, Casteca and Santa Feliciana were worked between the years of 1834 and 1838 by the priests of the San Fernando and San Buena Ventura missions. The placers of San Gabriel Canyon were worked by the priests of San Gabriel Mission and also by the native Californians until the discovery of gold by Marshall in 1848 at Sutter's Mill. In recent years individual prospectors have attempted to work some of the gravels in these areas. The most recent attempt at placer mining has been in Texas Canyon 10 miles northeast of Saugus.

Gold-bearing quartz veins have been mined for gold in past years, but at present writing there is no producing gold mine in the county. Such gold as is shown in the production table (*ante*) for 1923-1926 has come mainly as a by-product from the lead-silver and copper ores. In the northwestern part of the county are several gold districts which were reached from Acton, a station on the Southern Pacific railroad.

The Cedar Mountain District is located north and west of Acton in Townships 4, 5 and 6 North, and Ranges 12 and 14 West. The productive mines of this district have been the Red Rover and New York mines.

The Mount Gleason District is located on and around Mount Gleason in Secs. 25, 26, 35, 36, T. 4 N., R. 13 W., S. B. B. and M. The principal mines of this district were the Padre, Mount Gleason, Kelly and Casa Grande mines. The mines of this district have been idle for years,

although some work has been done on the Mount Gleason Mine in recent years. In this general area is located the Monte Christo Mine, which is 16 miles southeast of Acton. On this property some development has been under way in recent years and attempts made to mill the ore, but the recovery made by amalgamation was low.

Another region of gold-bearing quartz was in the San Gabriel Range adjacent to the canyons of the San Gabriel River. The principal mines of this district that have been productive in the past are Allison, Big Horn, Kelsey and Victoria, which are reached from Azusa, by way of San Gabriel Canyon.

MINES.

Allison Mine. (Quartz.) It is located on the west slope of Sheep Mountain, 5 miles northeast of Azusa. Owner, Allison Mines Company, Azusa, California.

Big Horn Mine. (Quartz.) It is located in Sec. 7, T. 3 N., R. 8 W., S. B. B. and M., on North Baldy Mountain, 28 miles east of Palmdale. Owner, Lowell and California Development Company, Los Angeles. Holdings comprise 15 patented claims. Idle.

Bibl: State Mineralogist's Reports XV, p. 477; XVII, p. 203.

Champion Group of Mines. It comprises 15 claims located in Sec. 28, T. 5 N., R. 14 W., S. B. B. and M., $3\frac{1}{2}$ miles northeast of Saugus. Elevation 2000 feet. Owner, S. B. Drum, Los Angeles, California. Four parallel veins of quartz occur in granite with a general east and west trend. Veins vary in width from 2 to 4 feet. The ore is oxidized quartz near the surface, but at a depth of 50 feet the quartz is heavily mineralized with pyrite. The ore is said to average \$11 per ton in gold.

Development consists of two tunnels and a number of shallow prospect shafts. Tunnel No. 1 has been driven 540 feet on the vein. Tunnel No. 2 is 290 feet in length on vein No. 3. Total development work on the different veins amounts to 2000 feet. Idle.

Cruzan Placer Mine. It comprises 640 acres located along Texas Canyon 2 miles northeast of Texas Canyon Mine and 12.8 miles northeast of Saugus. Elevation 2350 feet. Owner, W. H. Cruzan, of Newhall.

The auriferous gravel deposits are on the north side of the canyon and their general course is northeast, being one-quarter of a mile wide and two miles in length.

Water for working these deposits is secured from a dam in Texas Canyon one mile above present workings. A high bench is being worked and the gravel at this point is 8 to 10 feet thick. The gravel is shoveled into a sluice from which it passes through a revolving drum, then onto fine-size screen before going to a large rocker driven by a 3-h.p. gas engine. The gold recovered is quite fine and the gravel can only be worked during the winter months due to limited water supply. One man is employed.

Dawn Mine. (Quartz.) It is located in Millard Canyon on the southwest slope of Mount Lowe, in SW $\frac{1}{4}$ Sec. 25, T. 2 N., R. 12 W., S. B. B. and M., 6 miles north of Altadena. Owner, M. T. Ryan, Los Angeles.

A vein of quartz in granite strikes east. Ore is heavy pyrite, said to carry gold values. Idle.

Bibl: State Mineralogist's Report XV, p. 477.

Dewey Group of Mines. It comprises four claims and a mill site, located on the southeast slope of Mount Gleason, near the head waters of the North Fork of Mill Creek, 8 miles south of Acton. Owner, I. Dewey, of Glendale, California. Development consists of shaft and tunnels. Idle.

Double Eagle Mine. (Quartz.) It is located 19 miles northeast of Saugus, in Sec. 21, T. 6 N., R. 14 W., S. B. B. and M., on the Bouquet Canyon and Elizabeth Lake road. Elevation 3250 feet. Holdings comprise six claims, known as Double Eagle Group of Mines. Owners, J. C. Nimmo and F. W. Kent, of Saugus, California. Under option to the Double Eagle Mining Company, B. V. Dermody, president; Walter Gow, secretary. Offices, Saugus, California.

A series of parallel quartz veins occur in the granite, strike N. 15° W., with dips varying from 40 to 65° to the northeast. Veins vary in width from 12 inches to 3 feet. The principal work has been done on the Double Eagle, Gold Pin and Winze veins.

These veins have been opened up by means of shafts and short tunnels. Development work consists of an incline shaft 125 feet deep. At a depth of 65 feet, a crosscut has been driven northeast 100 feet to the Gold Pin Vein. The main working tunnel has been driven north as a crosscut 600 feet and at 489 feet from the portal, a drift has been driven N. 55° W., 80 feet, on what is said to be the Gold Pin Vein. The ore is oxidized quartz, carrying a small percentage of pyrite. Ore milled from surface workings is said to have a value of \$8 to \$10 per ton in gold. Equipment consists of Gardner-Rix compressor, blacksmith shop, air drills and cars. Mill equipment consists of 20-ton Herman Ball mill, amalgamation plates and concentrator. The mill is driven by 22-h.p. Western gas engine. Three men are employed.

Eagle Mine. (Mt. Gleason.) It is situated on the north slope of Mount Gleason, 6 miles south of Acton, a station on the Southern Pacific Railroad. Elevation 6000 feet. Holdings comprise two patented claims and mill site, also 17 claims held by location. Owner, Mount Gleason Mining Company, Chas. E. Walker, president; E. G. Gilbert, secretary, 440 Wilcox Building, Los Angeles.

The Eagle Vein strikes northwest and dips 80° northeast in granite. The vein is 2 to 6 feet wide. The quartz is shattered and contains a small percentage of pyrite. The quartz near the surface was oxidized and was free milling. Developments consist of tunnels and shafts. Idle.

Bibl: State Mineralogist's Reports IX, p. 195; XI, p. 247; XII, p. 152; XIII, p. 204.

El Centro Mine. (Quartz.) It comprises 6 claims located 12 miles west of Cajon, on the Prairie Fork of San Gabriel River. Elevation 5550 feet. Owner, Guy Pullen, San Bernardino, California. Ore occurs in a basic porphyry dike heavily stained with hematite that occurs in gneiss. Development consists of a tunnel 50 feet in length and shallow shafts. Idle.

Lummis Group of Mines. It comprises 4 claims located 7 miles southeast of Acton, on the North Fork of Alder Creek in Sec. 8, T. 3 N., R. 11 W., S. B. B. and M. Elevation 4700 feet. Owner, Capt. Lummis.

A vein of quartz 2 feet wide occurs in granite. It strikes east. Development consists of a tunnel 20 feet in length and shallow shafts. Idle.

Monte Christo Gold Mines. (Quartz.) Property is situated near the head waters of the east fork of Mill Creek, 18 miles southeast of Acton. Elevation 4650 feet. Holdings comprise 10 claims, totaling 200 acres. Owner, F. W. Carlisle, Acton, California.

Four parallel veins occur in the granite which strike N. 20° W. and dip 80° east. These veins vary in width from 2 to 6 feet. Development consists of 6 tunnels and several shafts on the different veins. The main development work, which is confined to the Monte Christo Vein, consists of two tunnels and a shaft 133 feet deep. At an elevation of 4650 feet, a tunnel has been driven north 275 feet. Four shoots of ore were developed on this level about 35 feet in length, with average width of 3 feet. The lower tunnel is 100 feet vertically below this tunnel and has been driven north 400 feet. The tunnels are connected by a raise. The ore shoots developed in the upper tunnel were stoped to the surface. It is reported that the production was \$70,000 in gold. The ore above upper tunnel level was free-milling gold quartz carrying a small percentage of pyrite. The ore encountered in lower tunnel is heavy pyrite ore which is not amenable to amalgamation. It is stated that the average ore on this level carries \$10 per ton in gold. At the present writing only assessment work has been done on the property. Equipment consists of 6" x 12" Blake crusher, 5-foot Huntington mill.

Bibl: State Mineralogist's Report XIII, p. 204.

Native Son Mine. (Quartz.) It comprises seven claims located on the south slope of the ridge north of the Prairie Fork of San Gabriel River, 12 miles west of Cajon, a station on the Southern Pacific Railroad. Elevation 5800 feet. Owner, Native Son Mining Company, Chas. Ward, president; F. E. Williams, secretary, San Bernardino, California.

The gold occurs in quartz stringers in mica schist and gneiss. The ore is free-milling with a small percentage of iron sulphides. The vein strikes northeast and dips 50° northwest.

Development consists of 6 tunnels driven at different elevations on the lode. The lower tunnel is driven as a crosscut 500 feet northeast, then a drift is run north 250 feet. No ore was developed in this tunnel. The other tunnels vary in length from 100 to 300 feet. The principal production came from two opencuts. The production is reported to have been \$7,000. The property was worked under lease by the Allison Mines Company from 1917 to 1920. Equipment consists of Rex air compressor, blacksmith shop and 3-stamp mill. Idle.

New York Mine. (Quartz.) It comprises three claims located in the Cedar Mining District, 3 miles north of Acton. Elevation 3400 feet. Owner, M. A. Newmark, of Los Angeles.

This property was one of the principal producers of this area. The vein of quartz strikes northeast and dips 75° north. Average width of vein is 4 feet. Development consists of a number of tunnels. The

main working tunnel is 800 feet in length, from which a winze has been sunk on the vein to a depth of 100 feet. Only assessment work has been done on the property in recent years.

Bibl: State Mineralogist's Reports IX, p. 192; XV, p. 476.

Red Rover Mine. (Quartz.) It comprises 4 claims situated in the Cedar Mining District, 4 miles north of Acton, in Secs. 22, 23, T. 5 N., R. 13 W., S. B. B. and M. Elevation 3350 feet. Owners, William Bowers and John B. Bowers, of Los Angeles.

This mine was the most productive mine of the Cedar Mining District but has been idle for years. The vein occurs on contact of syenite and slate and strikes N. 63° W. and dips 80° south. The principal work was done through an incline shaft on the vein 535 feet deep and a vertical shaft 400 feet deep. About 500 feet north of these workings on the Rip Van Winkle claim are two shafts, one near the top of the ridge, at an elevation of 3650 feet, being 150 feet deep. At 100 feet in elevation below the collar of the shaft, a crosscut tunnel has been driven S. 55° W. several hundred feet, connecting with the shaft. At an elevation of 3500 feet, there is another shaft about 100 feet in depth. The ore milled from the property is said to have had an average value of \$10 per ton in gold. Idle.

Bibl: State Mineralogist's Reports VIII, p. 333; IX, p. 201; XI, p. 246; XII, p. 153; XIII, p. 204.

Texas Canyon Placer Mine. It comprises Texas and Woodrow Placer Group of Claims, totaling 230 acres, located in Texas Canyon, 10 miles northeast of Saugus. Owners, John Caspar and Robert Heinze, of Los Angeles.

On the north side of the canyon are auriferous gravel deposits that occur along a bench above the canyon. It has been worked for a distance of one-quarter of a mile. The channel has a general northeast course. The gravel is about 6 to 8 feet thick. The gold is quite fine. The gravel is composed of metamorphic rocks, schist, slate, quartzite and some quartz. Various attempts have been made to work the gravel by means of pumping water from the creek and washing with sluices. The deposit has been worked only intermittently by the owners, due to the scarcity of water. Idle.

Union Mine. (Quartz.) It comprises one claim, situated in the Cedar Mining District, 4 miles northwest of Acton. Elevation 3350 feet. Owners, T. G. Schafer and Ira L. Houser, Acton, California.

The quartz vein 4 feet wide strikes northwest and dips 80° south, in schist. Developments consist of a shaft 140 feet deep, with a drift southeast from the 60-foot level a distance of 50 feet and stoped to the surface. Ore shoot is said to be 6 inches to 4 feet wide, with an average value of \$10 per ton in gold.

Equipment consists of gasoline hoist and 5-stamp mill. The property has not been operated since 1900. Only assessment work done on one claim.

IRON

Titaniferous iron ores occur in Los Angeles County in the San Gabriel Mountains, south of Soledad Canyon. The known deposits occur in this range of mountains in a southeasterly direction from Sand

Canyon to the headwaters of Tujunga River. The principal occurrences of titaniferous magnetites of this region are located in T. 4 N., R. 14 W., on the ridge south of Soledad Canyon, extending for a distance of 5 miles easterly from Lang to Russ Siding, on the Southern Pacific Railroad, and also in T. 3 and 4 N., R. 12 and 13 W., in an area southwest of Mount Gleason and north of Tujunga Canyon in the vicinity of Mill Creek and its tributaries.

The titaniferous ores of this region are associated with rocks of the gabbro family. The largest orebodies are contained in rocks that are chiefly labradorite, in coarsely crystalline granitoid aggregates that have been called anorthosite by the Canadian geologists. The anorthosite is a nearly pure plagioclase rock in which labradorite is the predominant feldspar. The ore consists almost entirely of magnetite and ilmenite with little visible gangue. During the past two years a great deal of experimental work has been carried on in the vicinity of Los Angeles on the titaniferous ores for the purpose of manufacturing titanium products. The following companies and individuals have testing plants under operation: Burdick Minerals Corporation; F. F. Burdick, of Hermosa Beach; H. D. Rankin and Associates, El Segundo, California, and the Titanium Corporation, Ford Von Bichowsky, Burbank, California.

TITANIFEROUS IRON DEPOSITS.

Mill Creek Deposits.

Baughman Group of Claims. It comprises 18 claims known as: Coldwater, Condor, Cogswell, Daytonian, Labradorite, Lodestone, Mary Jane, Rake and Titan groups located 8 miles southeast of Acton, east and west of Mill Creek, a tributary of Tujunga Canyon. Elevation 3700 and 4500 feet. Owners, William Baughman and Associates, Los Angeles.

These properties are accessible by road from Acton, a station on the Southern Pacific Railroad, over the Aliso Canyon road to George Cogswell's Camp, a distance of 12 miles and then by trail on Mill Creek, a distance of 4 miles.

The most extensive deposit of iron ore is on the Titan Group of claims which are located in the NE $\frac{1}{4}$ of Sec. 23, T. 3 N., R. 12 W. On a ridge south of Fuller Creek and east of Mill Creek there is exposed a massive outcrop of titaniferous iron ore with an average width of 10 feet and about 300 feet in length. The ore occurs in anorthosite, a white labradorite. The normal strike of the orebody is north. The exposure on top of the ridge is 350 feet vertically above the exposure in the canyon. It is estimated that the deposit contains about 250,000 tons of ore of commercial grade. In general the orebody is a medium to coarse-grained magnetite containing little visible gangue. The anorthosite and ore are in most cases in this deposit in sharp contact, with little, if any, increase in the amount of ferrie minerals in the anorthosite as the ore is approached. There seems to have been a complete differentiation of the ferruginous and titaniferous minerals on one hand and the feldspathic on the other. In the one rock, iron oxide and titanium oxide crystallized by themselves; in the other, silica, alumina, soda and lime. The high-grade ore consists of coarser-grained aggregates of magnetite and ilmenite, containing little gangue. It is

stated that the ore from this deposit carries from 11% to 25% ilmenite, TiO_2 and 40 to 50% magnetite, Fe_3O_4 .

Lodestone Deposit. This deposit is located about one mile north of the Titan deposit, on a ridge east of Mill Creek and also on west of this creek in the NW $\frac{1}{4}$ of Sec. 14, T. 3 N., R. 12 W. The outcrop of iron ore is about 5 feet wide and 100 feet long. The ore is said to carry 7 to 18% ilmenite. Across Mill Creek, on the west slope of the ridge, is an outcrop of low-grade ore 10 feet wide by 20 feet long.

On Daytonia No. 1 and 2 claims, several small outcrops of ore occur on the ridge north of Fuller's Creek and east of Mill Creek. These outcrops are from 3 to 8 feet wide and about 25 feet in length.

Condor Deposit. This deposit is located on the ridge between Cold-water Canyon and the north fork of Tujunga Canyon. The exposure of iron ore is 50 feet in length by 20 feet wide and is said to carry 15% ilmenite and 40% magnetite.

Iron Mountain Group of Mines. This group comprises 18 claims located on the north slope of Little Iron Mountain about one mile southeast of the Titan Group. Elevation 4800 feet. Owner, F. F. Burdick, Hermosa Beach, California.

Several small outcrops of iron ore occur on these claims. No development work has been done on the deposits to determine their extent.

Mammoth Group of Claims. This group comprises two claims located on Mill Creek, two miles southwest of Titan Group of Mines. Owner, F. F. Burdick, Hermosa Beach, California.

Bryant Group of Claims. This group comprises three claims situated in T. 3 N., R. 13 W., S. B. B. and M., on the south slope of Iron Mountain, near the headwaters of Trail Canyon. Small exposures of iron ore occur on these claims. R. Bryant, owner.

The Titaniferous Iron Ores of Region South of Soledad Canyon, in T. 4 N., R. 14 W., S. B. B. and M.

Iron Blossom Group of Claims. This group comprises 23 claims located on a ridge between Pole and Bear Canyons and south of Soledad, one-half mile southeast of Lang, a station on the Southern Pacific Railroad. Elevation 3500 feet. Owners, Oliver Andreason and W. B. Allison, Los Angeles.

Several outcrops of titaniferous iron occur near the top of the ridge. These exposures are 6 to 8 feet wide and about 30 to 50 feet in length. A large amount of high-grade float is found scattered over an extensive area. The country rock is gabbro and anorthosite.

The high-grade ore is being sacked and packed by mules to Soledad Canyon, where it is loaded in trucks and hauled to the mill of the Caliproducs Company, located near Ravenna, where it is ground and then shipped to Rankin's test plant at El Segundo for the manufacture of titanium oxide. Five men are employed.

Iron Mack Mine. A deposit of titaniferous iron occurs in Sec. 36, T. 6 N., R. 14 W., S. B. B. and M., at the head of Mint Canyon, about 10 miles north of Acton. The ore is low grade and limited in extent.

Bibl: State Mineralogist's Report XV, p. 478.

Needham and Boruff Group of Claims. This group comprises three claims located in Iron Canyon, 4 miles south of Lang, a station on the Southern Pacific Railroad, in Sec. 31, T. 4 N., R. 14 W., S. B. B. and M. Owners, Fred Boruff and H. C. Needham, Newhall, California. Outcrops of titaniferous iron occur on these claims.

Russ Siding Iron Deposit. A small deposit of titaniferous iron occurs within 200 yards of the Southern Pacific Railroad, at Russ Station in Soledad Canyon.

Bibl: State Mineralogist's Report XV, p. 478.

Titian Group of Claims. Deposits of titaniferous iron occur on this group of claims located in Sec. 22, T. 4 N., R. 14 W., S. B. B. and M., 2 miles southeast of Lang, in Pole Canyon. Owner, F. F. Burdick, Hermosa Beach, California.

Burdick Minerals Corporation. F. F. Burdick, president; E. C. Carson, vice president; Willedd Andrews, secretary; Chester A. Scott, general manager; W. H. Test, chemical director. Offices, 330 Second street, Hermosa Beach, California. This company has under lease $2\frac{1}{2}$ miles of beach front near Clifton from the Huntington-Redondo Land Company.

Occurrences of titaniferous iron are found along the coast line of Los Angeles County in the beach sands. The most extensive concentration of this material is found south of Redondo and between that city and Palos Verdes. For a distance of $2\frac{1}{2}$ miles along the beach, from Clifton south, the beach sands contain a heavy concentrate of titaniferous iron. The deposit being worked is lenticular, varying in thickness from 8" to 14' of black sand with an overburden of gray and white sand.

The sand being worked probably contains 20% titaniferous iron and magnetite, the gangue being silica, olivine, epidote, garnet and zirconium silicate.

The sand from the beach is loaded by Northwest Engineering Company shovel into 31 cu. yd. cars, which are hauled by Plymouth locomotive one-quarter of a mile to the screening plant. The material from cars is dumped into hopper, from which it is elevated by bucket elevator to another hopper, from which the feed is split to pass over six Leahy vibrating screens, where it is screened to minus 30-mesh product. The screened product goes to collecting tank, from which it is transported by drag-line belt to bucket elevator that elevates the material to loading bins having a capacity of 200 cu. yds. The plant has a capacity of 1200 cu. yds. per 24 hours. Water for screening operations is pumped from the ocean. A fairly clean classification is made by this screening operation as the minus 30-mesh contains 60% mixed ilmenite and magnetite. The oversize is the tail product and is transported by belt conveyor to the ocean. The material from loading bins is hauled by trucks to the company's experimental plant at Hermosa Beach, where it goes to the stock pile. The company has 8 acres at 330 Second street for the site of a commercial plant. The material from stock pile is transported to experimental plant by drag-line scraper, where it is treated on a Diester-Overstrom concentrator. The table concentrate carries 65% ilmenite and 35% magnetite. The concentrate from table is dried and then treated by magnetic separator, where the final

products are clean magnetite and ilmenite. A clean separation of these two metals is possible, as ilmenite is nonmagnetic.

The company is experimenting with titaniferous iron ores for the manufacture of titanium oxide (TiO_2). Fourteen men are employed at screening plant, which is operated on a ten-hour shift.

Titanium Corporation Experimental Plant. Another experimental plant has been under operation during the past year on titaniferous iron ores for the manufacture of titanium nitride (TiN) using the Bichowsky process. Ford Von Bichowsky, owner, Los Angeles.

THE UTILIZATION OF TITANIUM.

The writer is indebted to Will Baughman, metallurgist, of Los Angeles, for the following article on The Utilization and Metallurgy of Titanium:

THE UTILIZATION AND METALLURGY OF TITANIUM.

By WILL BAUGHMAN, Metallurgist, Los Angeles.

Introductory.

Titanium is usually classed as one of the rare elements, although it is widely distributed. Nearly all igneous rocks, most clays and over half the metamorphic and sedimentary rocks contain easily determinable amounts. As a rule it is chemically combined with other than titanium minerals. Over sixty minerals have been classed as titanium minerals. Clarke has estimated that the solid crust of the earth contains about 0.73% titanium oxide.¹

In spite of this widespread distribution and the large number of titanium minerals, commercial concentrations, with the exception of titaniferous iron ores, the minerals rutile (titanium oxide) and ilmenite (titanite of iron) are the sole source of production of titanium. Some attention has recently been paid to the concentration of sphene (calcium titanio-silicate) which sometimes occurs in large pegmatite dikes to the extent of 6% or more. All commercial production has been made in the past from the first three minerals.

Titaniferous iron ores, almost always, occur in very basic rocks of igneous origin. When occurring in gabbro, norite or similar rocks, these ores generally occur as magmatic segregations. The occurrences in labradorite or anorthosite are often as igneous sheets or dikes.

From an ore-dressing viewpoint, the titaniferous iron ores can be divided into two classes. One class comprises those ores which contain the titanium as ilmenite in crystals that are large enough to permit crushing to reasonable mesh and then treating magnetically to produce a high grade ilmenite concentrate and a titanium-free magnetite concentrate. The deposits at Taberg, Sweden, at Sanford Lake, New York, and in the San Gabriel Mountains of California are the important deposits of this character.²

The other class of titaniferous iron ores includes both those ores in which the titanium is chemically combined and those ores in which the ilmenite crystals are so small or so interwoven that fine grinding and magnetic treatment will give neither a high titanium product nor

¹ Data of Geochemistry. U. S. Geol. Survey Bull. 770.

² Titaniferous Iron Ores of U. S., Singewald. U. S. Bureau of Mines Bull 64.

titanium-free iron material. Practically all the titaniferous iron ores are of this class.

Ores containing from 3% to 30% titanium oxide are classed as titaniferous iron ores. Those containing over 30% titanium oxide are classed as ilmenite. The titanium content of most titaniferous iron ores is under 15%.

Pure rutile is crystal clear, and when cut closely resembles white sapphire. Only a few pounds of such crystals have been found. Rutile generally contains several per cent of iron and often has appreciable vanadium content. The average commercial grade of rutile is 93% to 98% titanium oxide.

Ilmenite is the principal mineral used in the manufacture of titanium products. The commercial grade usually contains 52% to 60% of titanium oxide, although a lower grade material containing 32% to 35% of titanium oxide is also marketed.

As this article is concerned with the commercial aspects of the titanium industry, no attempt will be made to describe the various minerals or cover the chemical properties of or give analytical methods for titanium. Neither will the various deposits capable of commercial production be treated in other than the most sketchy manner. A bibliography will be given to cover this information for those desiring to make further investigations. Due to limited space, full credit can not be given to many splendid workers who have added to the world's knowledge of titanium.

Utilization.

RUTILE.

Prior to the discovery of the Virginia deposits, Norway furnished the world's supply of rutile. A small production, chiefly for mineral specimens, was also made in Georgia and Pennsylvania. In recent years rutile has been the raw material used in making titanium tetrachloride, potassium titanium oxalate and carbon-free ferro-titanium.

ILMENITE.

Ilmenite is treated by some chemical method to produce titanium oxide, which is then used as paint pigment, in glass, rubber or linoleum or for the manufacture of any of the materials that rutile is used for. Ilmenite is used for the manufacture of ferro-carbon-titanium without previous chemical refining.

TITANIFEROUS IRON ORES.

Magmatic segregations of titaniferous iron ores generally form lenses, more or less in line with each other, and the impression is often erroneously given that one large continuous body of ore exists. Furthermore, the gangue material is generally some dark, ferromagnesian mineral that to the casual observer appears to be titaniferous iron also, and while small stringers towards the center of such lenses may consist almost solely of ilmenite and magnetite, the general average of such orebodies is less than 40% ilmenite and magnetite.²

These two conditions have caused many deposits to be grossly overestimated both as to tonnage and grade. The deposits in Cook County,

² Titaniferous Iron Ores of U. S., Singewald. U. S. Bureau of Mines Bull. 64.

Minnesota, and just over the Canadian border in the Rainy River district and the deposits in Madagascar and at Magnet Heights near Pretoria, South Africa, are examples of this mistaken viewpoint. Information given by a magnetometric survey is much more reliable with such deposits than any ordinary geological investigation.

METAL INDUSTRY.

Smelting.

It is seldom that titaniferous iron ores contain over 45% metallic iron, as the titanium content decreases the grade in proportion to the amount of titanium present. Titaniferous iron ores seldom contain over 15% titanium oxide and ores containing as little as 3% have been placed in this class. This low iron tenor has prevented profitable smelting in the past. There is a tradition that titanium causes sticky slags and builds up accretions in the blast furnace, but Rossi has definitely disproved this.

Titaniferous iron was first smelted in the United States at Iron Mine Hill in Rhode Island before the Revolution. Later similar ores were smelted at Sanford Lake in the Adirondacks and at various other small blast furnaces. In Sweden and Norway the titaniferous magnetites had been smelted in charcoal blast furnaces and iron of a very high grade produced. This is probably due to the fact that most titaniferous iron ores contain only minute amounts of phosphorus and sulphur.

Experimental smelting of titaniferous iron ores has been conducted at Port Henry, New York,³ at Pueblo, Colorado, where titaniferous ores from Iron Mountain, Wyoming, were added to other ores, at several places in England, where imported Norwegian ores were used, and in New Zealand, where titaniferous beach sands (black sands)⁴ are being smelted.

Electric smelting has been experimented with by Gin in Europe and by Haanel, for the Canadian Government, in Ontario, Canada.

There is no question that titaniferous iron ores can be smelted, but the low iron content of such ores, together with a prejudice founded on legends which are not supported by any definite facts or reliable data, has prevented the utilization of these ores in the blast furnace more than any other factors.

FERRO ALLOYS.

Probably due to the fact that iron made from the sulphur and phosphorus-free titaniferous ores of Norway was of such high grade, Robert Mushet about 1860 conducted extensive experiments in adding titanium alloys to steel.

Titanium readily combines with nitrogen and oxygen and is therefore an excellent scavenger or final deoxidizer. Titanium as a constituent alloy of the steel does not appear to offer any advantages, with the exception of certain grades of cast iron. It is such an energetic remover of the last traces of oxygen and nitrogen that it is extensively used for the treatment of steels used in rolls and other places where resistance to shock and abrasion is desirable; for steel and iron castings and in material used for manufacture of chains, gears, forgings, tool and automobile steels.

³ Rossi. *Am. Inst. Min. Eng.*, Vol. 21, pp. 832-36; Vol. 33, pp. 170-197; *Iron Age*, Vol. 57, 1896, pp. 354-56 and 464-69.

⁴ Heskett. *Am. Inst. Min. Eng.* Aug. Meeting, 1920.

Titanium additions are made in three forms as ferro-carbon-titanium, as carbon-free ferro-titanium and as titanium thermit.^{6,7,9,10}

FERRO-CARBON-TITANIUM.

This alloy is made in the electric furnace. It contains about 15% titanium and 6% carbon. The titanium content could be raised, but this proportion alloys most readily with the molten iron or steel to be treated. The carbon is present as graphite. For treating wire or plate stock, 2–4 pounds of ferro-titanium are used per ton of steel, for axle stock 4–8 pounds, for steel castings 4–10 pounds and for steel rails about 15 pounds per ton of steel. About 9000 tons of ferro-carbon-titanium are used per year. The price has been from \$200 to \$225 per ton for several years.

CARBON-FREE FERRO-TITANIUM.

Carbon-free ferro-titanium is made by the 'Thermit' process. It contains 5% to 7% aluminum. The consumption is much less than that of the ferro-carbon alloy and the price is much higher. It is used in the better grade of castings and steels. Some difficulty has been encountered in the complete removal of the alumina which forms segregations in the steel.

TITANIUM THERMIT.

This consists of an intimate mixture of iron and titanium oxides (ilmenite) and aluminum powder which is placed in an iron container on the end of a steel rod. The whole is vigorously stirred into the bath.

The heat of the bath is sufficient to start the thermit reaction and the ferro-titanium is formed in the bath itself. This method of addition of titanium is used principally in making iron castings.

OTHER TITANIUM ALLOYS.

Cupro-titanium, ferro-cupro-titanium, ferro-silico-titanium, manganese-titanium and aluminum-titanium are used to a small extent in the brass industry. Cupro-titanium, for example, permits copper castings containing a small amount of this alloy to be cast in green sand without forming blow-holes.

There are several pyrophoric alloys in which titanium is an ingredient. None have any commercial importance.

Ferro-carbon-titanium is produced by the Titanium Alloys Company, of Niagara Falls, and the carbon-free alloy and titanium thermit is produced by the Metal and Thermit Corporation, of New York City. This latter company also makes most of the minor alloys mentioned.

TITANIUM NITRIDES.

Titanium nitride and cyano-nitride are two products that are new in a commercial sense. These nitrides when finely ground, suspended in water and sprayed on a mold and then dried prevent the adherence of the cast metal to the mold and cores can be easily removed by simple

⁶ Titanium. Canadian Dept. Mines. Mines Branch Bull. 579.

⁷ Titanium. U. S. Bureau Mines. Rept. Investigations No. 2406.

⁹ Browning. Introduction to the Rarer Elements; John Wiley & Sons, 1917.

¹⁰ Johnstone. The Rare Earth Industry; Crosby Lockwood & Son, London, 1918.

sand blasting. The surface of the casting is also much smoother. This is covered in patent No. U. S. 1,570,802.

PAINT INDUSTRY.

GREEN PIGMENTS.

The first proposal to use titanium compounds was as a substitute for poisonous arsenical green paints. The ferro-cyanide of titanium was proposed for this use. The cost of manufacture of this compound has been quite high in the past, but it now appears that this pigment can be cheaply produced by using the process of Bichowsky and Harthan for the manufacture of titanium-cyano-nitride with additional processing of the waste solutions and the products of this process. This green is very brilliant and quite permanent. It will be further discussed in the section devoted to metallurgy.

OTHER PIGMENTS EXCEPT WHITE.

Many titanium pigments have been proposed, none of which are at present on the market or which offer any attractive possibilities under present conditions.

Titanium tannate can be used as a water color pigment. The color ranges from brick red to pure yellow, depending on conditions observed in the preparation of the pigment.

Ilmenite, finely ground, can be used in the same manner as finely ground magnetite for making mineral black. The ilmenite forms a brighter pigment than magnetite.

Ilmenite or titaniferous iron ore can be roasted in air almost to fusion point and finely ground under water to produce pigments of red to yellow in color. The control of this roast, so as to produce a uniform product, offers many difficulties.

Light yellow pigments can be made by decomposing the ore with sulphuric acid and then roasting the mass at a temperature high enough to decompose the sulphates formed. Material so manufactured has been marketed.

TITANIUM WHITE.

The most important use of titanium compounds to date has been as the pigment known as titanium white or as known by the trade name 'titanox.' The Norse Titan Company produces about 3000 tons of titanium white pigment per year and the Titanium Pigment Company produces about 5000 tons per year.

Pure titanium oxide is too expensive to use as a pigment by itself and is therefore mixed with lithopone, barium or calcium compounds or with alumina. There are a large number of patents covering such mixtures. The standard mixtures contain about 25% titanium oxide. The balance is either lithopone or barium sulphate and calcium phosphate.

Titanium oxide does not blacken in sulphur or other acid fumes nor hydrolize as zinc pigments do in presence of brines or chlorides. Titanium oxide is very inert chemically and therefore a dryer must be added to the pigment. The use of small amounts of zinc or lead compounds for this purpose has been patented, but such pigments then contain the very elements and have the drawbacks that titanium oxide is supposed to obviate.

The following tables, given by Coffinger, show the specific gravity (S. G.) index of refraction (I. R.) and covering power by capacity (C. P.).

<i>Pigment.</i>	<i>S. G.</i>	<i>I. R.</i>	<i>C. P.</i>
Lead carbonate -----	6.81	1.99	115
Lead sulphate -----	6.41	---	---
Zinc oxide -----	5.66	1.90	100
Lithopone -----	4.30	---	---
25% 'titanox' -----	4.25	2.30	130
Pure titanium oxide-----	4.00	2.60	160

When properly mixed and proper driers and oils are used, titanium pigments withstand immersion in water for considerable periods, but if this is not done properly the paint becomes chalky even under favorable outdoor conditions. Titanox is an approved U. S. Navy paint.^{5, 6, 7, 9, 10}

DYES AND TANNING INDUSTRY.

A considerable amount of titanium compound is used annually in the dyeing industry. Titanous chloride and titanous sulphate are both used to 'strip' dyes where the color is either too deep or uneven, preparatory to redyeing. Some titanium compounds are used in the dyes themselves. Titanium lactate is used as a mordant and 'striker' in the leather industry under the trade name of 'corrichrome.' Basic sodium-titanium-sulphate and more particularly potassium-titanium-oxalate are used in a similar manner.

RUBBER INDUSTRY.

Titanium white is added to gutta-percha paints and titanium oxide is added to linoleum as a filler and to rubber to increase the strength and quicker vulcanization. A lowering of the price of titanium oxide would cause a very large increase in consumption for these two materials. The chemical inertness of titanium oxide makes it more desirable than materials which slowly act on the rubber.

LIGHTING INDUSTRY.

Metallic titanium filaments have been used in incandescent electric light. They were not as satisfactory as tungsten. The oxide has also been used in gas mantles. Finely powdered ilmenite and rutile have been used in direct current arc light carbons to give a source of light very rich in the ultra violet rays. Mercury vapor quartz lamps have largely replaced these arcs.⁸

WARFARE.

Titanium tetrachloride is used in warfare to make smoke screens. A considerable tonnage was so used in the World War. It is now used in sky writing.

⁵ Coffinger. *Chimie et Industrie*, Vol. 7, No. 4, Avril, 1922, pp. 651-661.

⁶ Titanium. Canadian Dept. Mines. *Mines Branch Bull.* 579.

⁷ Titanium. U. S. Bureau Mines. *Rept. Investigations No.* 2406.

⁹ Browning. *Introduction to the Rarer Elements*; John Wiley & Sons, 1917.

¹⁰ Johnstone. *The Rare Earth Industry*; Crosby Lockwood & Son, London, 1918.

⁸ Titanium. Hunter. *Jour. Am. Chem. Soc.*, Vol. 32, pp. 330-336.

CERAMIC INDUSTRY.

GLAZES AND PORCELAIN.

Titanium oxide, both as the refined material and as rutile, has been used for many years in forming the yellow glazes. It is an excellent substitute for the more expensive uranium oxide in most cases.

Titanium oxide is used in the porcelain of artificial teeth to give the yellowish color required.

Titanium occurs in most clays and its action is to lower the fusion point.

GLASS AND CEMENT.

One of the most attractive recent developments in the use of titanium oxide is as an addition to glass. Titanium oxide is used to replace silica up to 40%. The effect is to lessen the coefficient of expansion. The coefficient of expansion decreases rapidly with additions up to 15% and more slowly after that point. The recently patented Horak glass which contains several per cent of titanium and zirconium oxides has such a low coefficient of expansion that it may be heated to almost a dull red and plunged into ice water without shattering, and furthermore, such glass, when cracked by a blow, may be repaired by fusing over a bunsen burner. These developments are very recent, but they offer a large potential market for titanium oxide.¹⁷

Cement made from the slags obtained by smelting of titaniferous iron ores or made from sphene or other titaniferous materials are remarkably resistant to acid, and this new development also bids fair to assume large proportions.

And finally calcined rutile, finely ground and sintered, can be formed into chemical resistant articles that are capable of conducting both heat and electricity. Such a material should have a future in the chemical manufacturing industry. This, too, is a new development.

NITROGEN FIXATION.

It has long been known that cyanides can be formed by heating carbon and a sodium compound in an atmosphere of nitrogen, but the temperature required is so high that no material can withstand it. A slightly lower temperature can be used by addition of titanium to the above, but it remained for Bichowsky and Harthan to discover that fixation of nitrogen as either titanium nitride or as titanium-cyanonitride could be accomplished at a much lower temperature in the presence of finely divided iron. This process is now being tested on a large scale. Commercial success seems assured and two new titanium compounds will probably be put on the market before long.

The nitrides have been proposed as a fertilizer, but are too expensive for this purpose. The real use is as a starting point in the manufacture of cyanide, ammonia, titanium oxide and titanium-ferro-cyanide (green paint pigment). The nitrides are also used in heat treating and have a splendid field as a mold wash, which has been discussed under Metal Industry.¹⁸

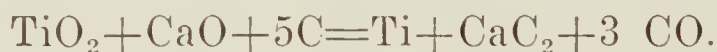
¹⁷ U. S. Pat. 1,362,917; U. S. Pat. 1,557,540; Barton and Horak.

¹⁸ Bichowsky and Harthan. U. S. Pat. 1,391,147; 1,391,148; 1,408,661; 1,417,702; 1,472,403.

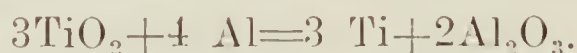
METALLURGY.

FERRO ALLOYS.

Ferro-carbon-titanium is made in the electric furnace by smelting ilmenite or titaniferous iron ores or mixtures of both and using charcoal as a reducing agent. The carbon content can be lowered by using rutile as a decarbonizing agent. Rich titanium slags are resmelted and lime is added to the slag where it forms calcium carbide and acts as a protective layer to prevent excessive oxidation of the titanium.



A carbon-free ferro has been made by melting scrap iron and scrap aluminum in the electric furnace. The molten aluminum forms a layer on top of the molten iron. Rutile is now charged and is reduced by the aluminum. The titanium sinks and alloys with the iron. Alloys containing 75% titanium can be made in this manner.



Carbon-free ferro is now made by the 'thermit' process, which consists in intimately mixing the proper amounts of ilmenite with aluminum powder, placing in a special smelting apparatus and igniting. The reaction is very vigorous and the whole mass becomes molten and is tapped off at the bottom.



The special copper alloys and the metal have so little use that space will not be given here to describe the methods of production. The reader is referred to the bibliography.

TITANIUM OXIDE RECOVERY.

As the ilmenite and rutile deposits are very few and the reserves not large, some method of recovering titanium oxide from titaniferous iron ores is desirable. Various systems that have been proposed will be mentioned and those possessing special merit briefly described.

One of the most obvious methods is to smelt the titaniferous ore with just enough carbon to reduce the iron so as to obtain all the titanium in the slag. As titaniferous iron ores almost always contain appreciable amounts of vanadium this method would also leave the vanadium in the slag from which a large portion can be leached with caustic soda solution.

Another method consists in fusing finely ground ore with sulphur which breaks up the iron titanate molecule and forms iron sulphide and titanium oxide. The iron sulphide can be removed by acids or by leaching with ferric chloride which dissolves the iron and leaves a residue of sulphur and titanium oxide. This last step might be followed by electrolytic recovery of the iron and regeneration of the ferric salt in a manner to be more fully described later on.

SULPHURIC ACID DECOMPOSITION.

The method used by the Norse Titan Company is to pulverize the ilmenite and thoroughly mix with sulphuric acid and then heat in gas fired kettles. As disintegration proceeds the mass swells and finally a

cake is produced which is crushed, ground and dissolved in water. The residue is returned for retreatment. The filtering problem is difficult and settling and decantation in large tanks is resorted to. The solution is then reduced electrolytically until all ferric iron is reduced to ferrous. The same result can be obtained by passing over scrap iron in long riffle boxes.

The reduced solution is boiled, which causes the titanium sulphate to become hydrolyzed and it precipitates as a bulky white precipitate. Barium chloride is added to remove the remaining amount of sulphuric acid and as 0.02% iron will discolor the product, the color of the iron is changed by converting it to the phosphate. As all their product is converted into pigment the titanium is further calcined to convert a portion of the amorphous oxide into the crystalline. If the refractive index of linseed oil is taken as unity then the amorphous oxide has an index of 1.48 and the crystalline an index of 1.80. The many crystalline faces act as minute mirrors and reflect the light, thus greatly increasing the brilliancy and whiteness of the pigment.

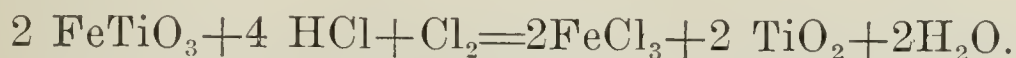
A method used in the United States is to reduce the iron oxide to sponge and then dissolve it with dilute sulphuric acid which leaves a residue of high titanium content. This residue is then heated with concentrated acid to dissolve the titanium and can either be diluted and hydrolyzed by boiling after all ferric iron remaining has been reduced to ferrous, or common salt can be added to the concentrated sulphuric acid solution to precipitate the titanium as basic sodium-titanium-sulphate.

Instead of precipitating the titanium by boiling the dilute sulphuric solution, it can be precipitated by hydro-oxides or by a tea made from wood shavings or sawdust.

Methods using fusions or roasts with soda ash, salt and similar alkaline compounds have been proposed, but offer technical difficulties that have not been overcome.^{5, 19}

CHLORINE METHODS.

One of the oldest methods of preparing titanium oxide is to heat ilmenite in a stream of dry hydrogen chloride and chlorine whereby the iron is volatilized as ferric chloride and the titanium oxide remains unaltered.¹¹



The ferric chloride could be used to dissolve iron in sponge iron made from titaniferous iron ores.

While this method works well on a small scale, those at all familiar with chlorine methods will readily see why such a method can not be operated on a commercial scale. It is mentioned here as so many persons have proposed it as a 'secret' process for treating titaniferous iron ores.

Another chloride process that is chemically correct but difficult of operation on account of the inability of materials to stand the heat and fumes is known as the Carterest-Devaux Process. Titanium ore

⁵ Coffinger. *Chimie et Industrie*, Vol. 7, No. 4, Avril, 1922, pp. 651-669.

¹⁹ Bachman. U. S. Pat. 1,489,417; Blumfeld, 1,504,669 to 673, inclusive; U. S. Pat. 1,511,323.

¹¹ Rosco and Schorlemmer. *Treatise on Chemistry*; McMillan & Co., 1907.
6-53688

is mixed with carbon and a flux and reduced in a furnace at red heat. Dry chlorine gas is then passed into the mass and the temperature rises. The different chlorides are formed successively as this rise in temperature occurs and are separated by fractional distillation, silicon chloride forming at 59 degrees and titanium chloride at 135 degrees Centigrade.⁵

The titanium chloride is taken up in solution and may be precipitated by boiling and hydrolysis or with barium carbonate. A large amount of wash waters are made from which various colored pigments have been made and chlorine and electrolytic iron can also be obtained as by-products by electrolysis of the ferric chloride, which simultaneously regenerates part of the chlorine for the first step.

SPONGE IRON AND ELECTROLYSIS.

The Whittemore Process,¹⁵ which closely resembles the Eustis and Perrin Process, has been taken up by the Canadian Government and considerable experimental work has been done.^{16, 20}

The process consists in first mixing the pulverized ore with a suitable reducing agent and then reducing the iron to 'sponge.' This mass is then leached with ferric chloride and filtered. Any copper or similar element is removed by precipitation as the sulphide. The ferric iron is reduced to ferrous iron during the leach. This purified ferrous solution is then electrolyzed in a diaphragm cell. Part of the iron is removed in the cathode compartment as pure iron and in the form of sheets or tubes. At the same time the ferrous chloride in the anode compartment is reoxidized to ferric and is ready for leaching a new lot of ore. The titanium remains in the residue from the leaching and requires further purification. It is possible to produce a product containing 80% titanium oxide by this method.

A voltage of 4.4 volts is required per cell and about two kilowatt hours of electricity are required per pound of iron produced. The diaphragms are also a constant source of trouble.

The other method of using sponge iron and electrolysis is known as the Baughman Process. It consists in metallizing at least 90% of the iron in the titaniferous iron ore in ilmenite, compacting same while hot into briquettes and using as soluble anode in an electrolytic cell. The cell used is much simpler than the Whittemore cell and has no diaphragm. Full advantage is taken of the anode reaction and only 0.60 kilowatt hours are required per pound of iron produced, or less than one-third the electricity requirements of the Whittemore Process. On the other hand, copper and certain other impurities can not be removed, and enter the iron. This is not serious, as most titaniferous ores are free of such impurities, particularly the Tujunga titaniferous iron ores for which the process was designed. Agitation of the solution and a much more rapid circulation of the electrolyte is used to remove the finely divided titanium oxide as fast as it is freed. Any vanadium present dissolves and is recovered during purification of the electrolyte.¹⁶

⁵ Coffinger. *Chimie et Industrie*, Vol. 7, No. 4, Avril, 1922, pp. 651-661.

¹⁵ Canada, Dept. Mines. *Mines Branch Repts. Investigations in Ore Dressing and Metallurgy*, 1924, pp. 91-102; 1925, pp. 71-88.

¹⁶ Belcher, Baughman. *Am. Elect. Chem. Soc.*, April, 1924, meeting paper No. 11, and discussion. Vol. XLV; and Hughes, *Am. Elect. Chem. Soc.*, Sept., 1921, Vol. XL; U. S. Pat. 1,542,350; also *Teknisk Tidskrift*, 12 Juni, 1926, *Bergsvetenskap* 6.

²⁰ Eustis and Perrin. *Min. and Met.*, Dec., 1921, p. 17.

¹⁶ Belcher, Baughman. *Am. Elect. Chem. Soc.*, April, 1924, meeting paper No. 11, and discussion. Vol. XLV; and Hughes, *Am. Elect. Chem. Soc.*, Sept., 1921, Vol. XL; U. S. Pat. 1,542,350; also *Teknisk Tidskrift*, 12 Juni, 1926. *Bergsvetenskap* 6.

Both these methods can be applied to titaniferous ores of any content of titanium. The other methods are designed for material containing upwards of 40% of titanium and are not efficient on ores of lower content.

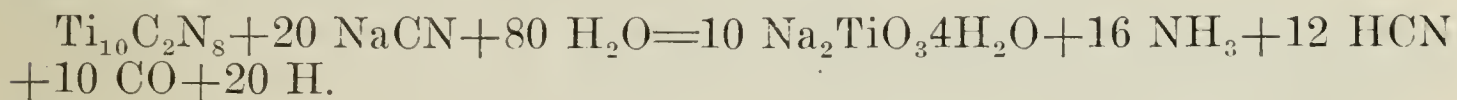
NITROGEN FIXATION.

A number of processes have been devised for the fixation of atmospheric nitrogen as sodium cyanide by heating sodium carbonate, carbon and nitrogen together in an enclosed furnace. The temperature required is quite high and these processes have failed as the apparatus has been quickly destroyed. The presence of titanium allows the fixation to proceed at a much lower temperature.

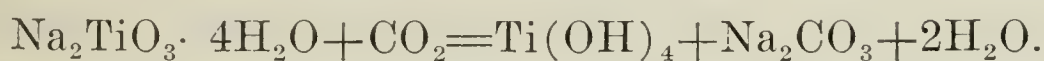
The process of Pacquet-Andreu is of this character and is reported to be in use in France. In the first step titanium oxide, sodium carbonate and carbon are heated in a revolving furnace in the presence of nitrogen.



In the second step the sodium cyanide and titanium cyanonitride are decomposed by steam forming ammonia which is absorbed in sulphuric acid and hydrogen cyanide which is absorbed in a soda solution and converting the titanium to sodium titanate.



In the last step the solution of sodium titanate is decomposed by carbonic acid producing titanium hydroxide.



This process requires rutile as a raw material and therefore is of limited value.

The processes of Bichowsky and Harthan can be used with ilmenite as a raw material or even high-grade titaniferous iron ores.

In the first step the iron oxide of the ilmenite is reduced by carbon to the metal, or what is commonly called 'sponge.' At the same time the titanium oxide molecule is freed from the iron oxide molecule. Nitrification is the second step and can be accomplished in the same or a separate furnace.

A calculated excess of carbon is used if the cyanonitride is desired. No excess carbon is used if the nitride (TiN) is desired.

The novelty of this invention lies in the discovery of the fact that this nitrification takes place at a much lower temperature in the presence of finely-divided metals of the iron group. The reduced iron in the sponge gives splendid results in this capacity.

After nitrification, which may take place either in the same furnace that reduction to sponge was accomplished in, or in a separate furnace, the mixture of metallic iron and cyano-nitride is finely ground and leached with dilute acid to remove the iron.

The cyano-nitride can then be used the same as in the Pacquet-Andreu Process to produce ammonia and sodium cyanide or, according to other patents of Bichowsky and Harthan, to make cyanide and ammonia. It can also be used to form the ferro-cyanide. For this purpose the iron solutions are used with the dilute cyanide solutions and the impure

ferro-cyanide so formed can then be used with the sodium titanate solution to make the titanium green pigment. This is the only practical method that has been proposed to make the green titanium pigment.^{5, 18}

PRINCIPAL OCCURRENCES OF TITANIUM ORES.

RUTILE AND ILMENITE.

United States.

There are some large pegmatite dikes in Nelson County, Virginia, that contain as high as 4% ilmenite and 4% rutile. The largest deposit, which is also the largest rutile deposit known, is a dike thirty feet wide and over half a mile long. The principal dike minerals are various feldspars and apatite. Several similar dikes three to five feet wide have been found near this large dike and in the neighboring counties of Amherst, Goochland and Hanover. The large deposit is owned by the American Rutile Company, which in turn is controlled by the Metal and Thermit Corporation. They operate a fine-grinding and magnetic separation mill at the deposit near Roseland, Virginia. The most promising of the other deposits are owned by the General Electric Company.¹³

At Graves Mountain in Georgia and at sundry places in the Carolinas and in Pennsylvania a little rutile has been produced in the past but the deposits are small and of low grade.

Rutile was formerly recovered as a by-product in the concentration of monazite sands in the Carolinas. Some rutile as well as considerable amounts of titanium are produced at Pablo Beach, Florida. The deposit consists of some 33,000,000 tons of beach sand containing over one per cent ilmenite and at least 1,000,000 tons of sand containing over five per cent ilmenite. A concentrating mill comprising tables, dryer, magnetic separator and finishing mills is operated on the deposit by Buckman and Pritchard, Inc., who are controlled by the same group that controls the Titanium Pigments Company. Monazite and zircon are also recovered at this plant. Most of the ilmenite supply used in the manufacture of 'titanox' comes from this deposit.

In California are two beach deposits of black sands containing ilmenite. The Triumph Steel Company is running an experimental plant at the deposit at Aptos, Santa Cruz County. The black sand contains magnetite, ilmenite and chromite. They intend to produce sponge iron and titanium and chromium alloys and products.

The beach sands at Clifton will average 7% ilmenite for a distance of three thousand feet. The beach is narrow, seldom being over one hundred feet wide. There are large concentrations of almost pure magnetite and ilmenite that contain 60% ilmenite and 40% magnetite. These concentrations are lens-shaped and about five feet thick, one hundred feet wide and one hundred and fifty feet long. The Burdick Mineral Company plans to operate on this deposit.

Neither of the California deposits contains commercial amounts of zircon or monazite.

⁵ Coffinger. *Chimie et Industrie*, Vol. 7, No. 4, Avril, 1922, pp. 651-661.

¹⁸ Bichowsky and Harthan. U. S. Pat. 1,391,147; 1,391,148; 1,408,661; 1,417,702; 1,472,403.

¹³ Virginia Deposits. Va. Geol. Survey, Bull. III A, 1913.

Canada.

The third largest known deposit of rutile is at St. Urbain in Quebec. It forms as much as 20% of a large deposit of ilmenite in spots but the general average content of rutile is 6%.

This is one of the largest ilmenite deposits known. Exposures 70 feet and 90 feet wide have been made of almost pure ilmenite. Many small exposures ten to thirty feet wide exist.

Another large ilmenite deposit is at Ivry, also in Quebec. A face 100 feet wide and 30 feet high of ilmenite has been exposed here. This deposit is owned by the Titanium Alloys Company. The St. Urbain deposit is owned by the General Electric Company.⁶

Norway.

The Norse Titan Company has a plant for making titanium pigments at Fredrikstad. They own deposits at Laxedalsfelterne estimated to contain 250,000 tons of 35% titanium content, ilmenite; at Blaaffeldt 100,000 tons of 40% to 45% ilmenite and at Storgargen over 3,000,000 tons of 25% ore. The latter is a large dike of ilmeno-norite cutting labradorite. The dike is 30 to 70 meters wide and three kilometers long.

Other Occurrences.

Commercial production of ilmenite has been made from beach sands at Travancore, India, and at Ceylon. Ilmenite has been produced in Portugal and from beach sands in Brazil. The Indian, Ceylonese and Brazilian sands are primarily worked for monazite, zircon and similar minerals.

In Australia, ilmenite has been produced in small amounts at Olary and minor amounts of rutile at Mt. Crawford.

During December, 1926, the Cia. Montecatini, the largest producer of chemicals in Italy, started production of titanium oxide, in a newly erected plant, at Bovisa, near Milan, Italy. It is presumed that the source of raw material is the extensive black sand deposits found on almost every beach on the Adriatic Coast. These deposits average 5% ilmenite and have been the subject of many articles in Italian journals. The ilmenite is easily separated magnetically.

At Kuju, Japan, is an extensive black sand deposit containing 5% titanium oxide that can be recovered as a by-product in the large sponge iron plant recently placed in operation by James W. Neill for the Tokiwa Company.

There are also large deposits of titaniferous beach sands on the coast of Nigeria, in Africa.

The black sand deposits at Sedro-Woolley, Washington, contain 11% titanium oxide. A 10-ton per day experimental blast furnace to recover iron from this extensive deposit was operated in 1920.

TITANIFEROUS IRON ORES.**United States.²**

The largest deposit of titaniferous iron in the United States is located at Sanford Lake in the Adirondacks. The ore contains from 10% to 20% titanium oxide. Professor Emmons estimates that there is nearly

⁶ Titanium. Canadian Dept. Mines. Mines Branch Bull. 579.

² Titaniferous Iron Ores of U. S., Singewald. U. S. Bureau of Mines Bull. 64.

seven million tons of ore of all grades at this deposit. It is eighty miles from the nearest railroad. Reported as owned by the Nippissing Mining Company.

The second largest deposit is at Iron Mountain, Wyoming. It is owned by the Colorado Fuel and Iron Company. The vein is 50 feet to 100 feet wide and contains 20% to 25% titanium oxide. The vein outcrops at various points on a ridge a mile long. The ilmenite can not be separated from the magnetite magnetically.

The third largest deposit is at Cumberland, Rhode Island. The ore is two-thirds gangue. The proved outcrop is 600 feet wide and 1500 feet long. A product containing 22% titanium oxide and 54% metallic iron can be made magnetically.

The fourth largest deposit or rather area in which titaniferous iron ores are found is northeastern Minnesota, principally near Iron Lake and in Cook County. There is no question that there is a large amount of ore scattered over a large area. The titanium content runs from 3% to 20% as a rule, although 40% samples have been obtained. Most of the rock contains very dark ferro-magnesian minerals as gangue material which with casual inspection appears as all ore. Very few outcrops are even 100 feet long or over 10 feet in width, although the number of smaller outcrops is very large. This same ore zone extends over the border into the Rainy River region in Ontario, Canada, where three outcrops over 150 feet long and over 30 feet in width of medium grade material have been found.^{2,6}

The fifth largest deposit is located at the head of the Tujunga in the San Gabriel Mountains, Los Angeles County, California. The largest outcrop is much larger and of much better grade than any of those in Minnesota. The largest single deposit contains about 225,000 tons of 15% to 27% ore and there are several very large, low grade, disseminated deposits. The region probably contains 2,000,000 tons of workable titaniferous iron ore.

Deposits of little or no importance occur in the Carolinas, in Tennessee, in New Jersey, in Colorado and in Tehama County, California.²

Canada.

Many small deposits are found throughout Quebec and Ontario, some seventy deposits being listed by the Canadian Department of Mines. The two deposits of commercial importance are the black sand deposits along the lower St. Lawrence and at Rainy River in western Ontario. This latter deposit is a continuation of the Cook County, Minnesota, deposits and remarks made about the Cook County deposits apply to the Rainy River deposits, which are comparable to the Cook County deposits in size and general character.⁶

Of all American deposits of titaniferous iron, only a portion of the Adirondack deposit, some of the very small Carolina deposits and the deposit in Los Angeles County, California, are capable of being separated, with reasonable grinding, into a high-grade ilmenite and a low-titanium magnetite.

² Titaniferous Iron Ores of U. S., Singewald. U. S. Bureau of Mines Bull. 64.

⁶ Titanium. Canadian Dept. Mines. Mines Branch Bull. 579.

² Titaniferous Iron Ores of U. S., Singewald. U. S. Bureau of Mines Bull. 64.

⁶ Titanium. Canadian Dept. Mines. Mines Branch Bull. 579.

European.

Some titaniferous iron ores as well as rutile are found in Transylvania and in the Carpathian Mountains. The huge igneous sheets at Kirunavarra, Sweden, and in the Urals in Russia contain a few per cent of titanium. The ores at Taberg Sweden, can be separated magnetically into ilmenite and magnetite. The deposits there have been worked for many years. Vanadium was first found in the Taberg titaniferous iron ores. Other minor occurrences of titaniferous iron ore are found in Norway and Sweden, in the Swiss, French and Italian Alps and in Spain and Portugal.

African.

On the Vongoabe River in the Betsiriry district of Madagascar is a large deposit of titaniferous material reputed to contain 3,500,000 tons of 40% titanium oxide content. A sample sent to the present writer closely resembles the Cumberlandite of Rhode Island. The letter accompanying gave data on the size of the deposit, which is about 35 meters wide and nearly a kilometer long. This would make the deposit about half the size of the Rhode Island deposit.

There is also a large area in the Transvaal over which titaniferous iron ores are found. The largest deposit is at Magnet Heights north of Pretoria. A recent published estimate states that there is some 24,000,000 tons of 14% titanium oxide and 60% metallic iron. The same article states that the veins average four feet in width. This analysis is obviously of specimen stuff and not of a grade that could be steadily produced. The bulletins of the Government (Union of South Africa) make no estimates of tonnage and cite the material as containing less than 40% iron and 10% titanium oxide. As no development work, even trenching, has been done, it is probable that the above estimate is in a class with the estimates of ore at Cook County and in the Rainy River districts in Minnesota and Ontario.²¹

VALUE OF TITANIFEROUS ORES.

The following quotations are principally from the *Engineering and Mining Journal*. Those marked (\$) are for material delivered at Atlantic ports. Others are prices at the mines. Prices are for the month of May for each respective year.

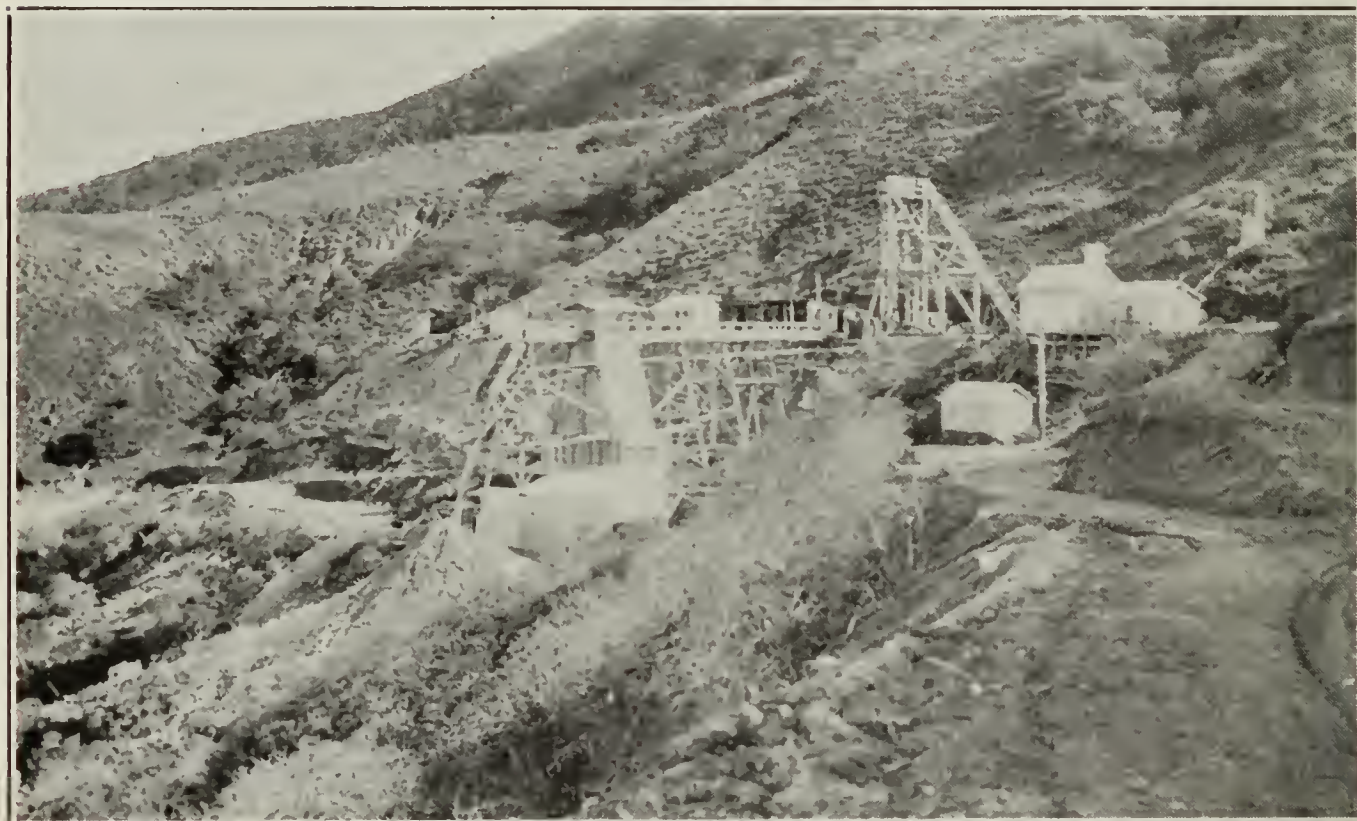
		1924	1925	1926	1927
Rutile 96% TiO	per lb. -----	11¢-30¢	10¢-30¢	12¢-30¢	11¢-13¢ (#)
Ilmenite 52% TiO	per lb. -----	1¼¢-1½¢	1½¢- 2¢	1½¢- 2¢ (#)	½¢- ¾¢ (#)
Ilmenite 35% TiO	per ton -----	\$7.50	-----	\$6.75	\$7.00-\$8.00 (#)
Titaniferous Iron Ore Under 25% TiO	per ton -----	\$3.50	-----	----	\$5.60 (#)

²¹ Eng. & Min. Jour. May 14, 1927, Vol. 123, No. 20, p. 807; Chemistry of the Rarer Elements, B. Smith Hopkins, D. C. Heath Co., 1923; Treatise on Inorganic Chemistry, J. W. Mellor, Longman Green, 1927, Vol. 7; Ullman Enzyklopede der Technischen Chemie, Vol. 11, Urban & Schwarzenburg, Berlin.

LEAD-SILVER AND ZINC.

The occurrence of these metals in Los Angeles County is not abundant. Their principal production is from the lead-silver-zinc deposits of Santa Catalina Island.

The mining and development of the ores on Catalina Island was started shortly after William Wrigley, Jr., purchased the island in 1919 and since that date there has been a steady production of these metals by the Santa Catalina Island Mining Company, of Avalon, California. Lead-silver-zinc ores occur in the Silver Mountain Mining District, east of Castac Cañon,¹ and the San Gabriel Canyon District north of Azusa.² These metals also occur associated with the copper ores of Pacoima Canyon District.³



Headframe and Bins, Black Jack Mine, Santa Catalina Island, California.

Mines.

Black Jack Mine. (Lead-Silver-Zinc.) It is situated on the northeast slope of Black Jack Mountain, 2 miles west of White's Landing and 14 miles by road northwest of Avalon, Santa Catalina Island. Elevation 1540 feet. Owner, Santa Catalina Island Company; William Wrigley, Jr., president; D. M. Renton, vice president and general manager; David P. Fleming, secretary; E. H. Pattison, consulting engineer. Offices, Avalon, California.

The vein occurs in a belt of hornblende schist that strikes northeast and dips 70° east. It trends N. 30° W. and dips 60° E., and varies in width from 4 to 25 feet. The vein is mineralized with sphalerite, galena and pyrite. The gangue minerals are hornblende, quartz, barite, calcite and muscovite. The ore-shoot developed from the surface to the 400-foot level was 40 feet in length and from 6 to 12 feet in width. The ore developed on the 100-foot level is 100 feet long and has an

¹ State Mineralogist's Report IX, pp. 203-204.

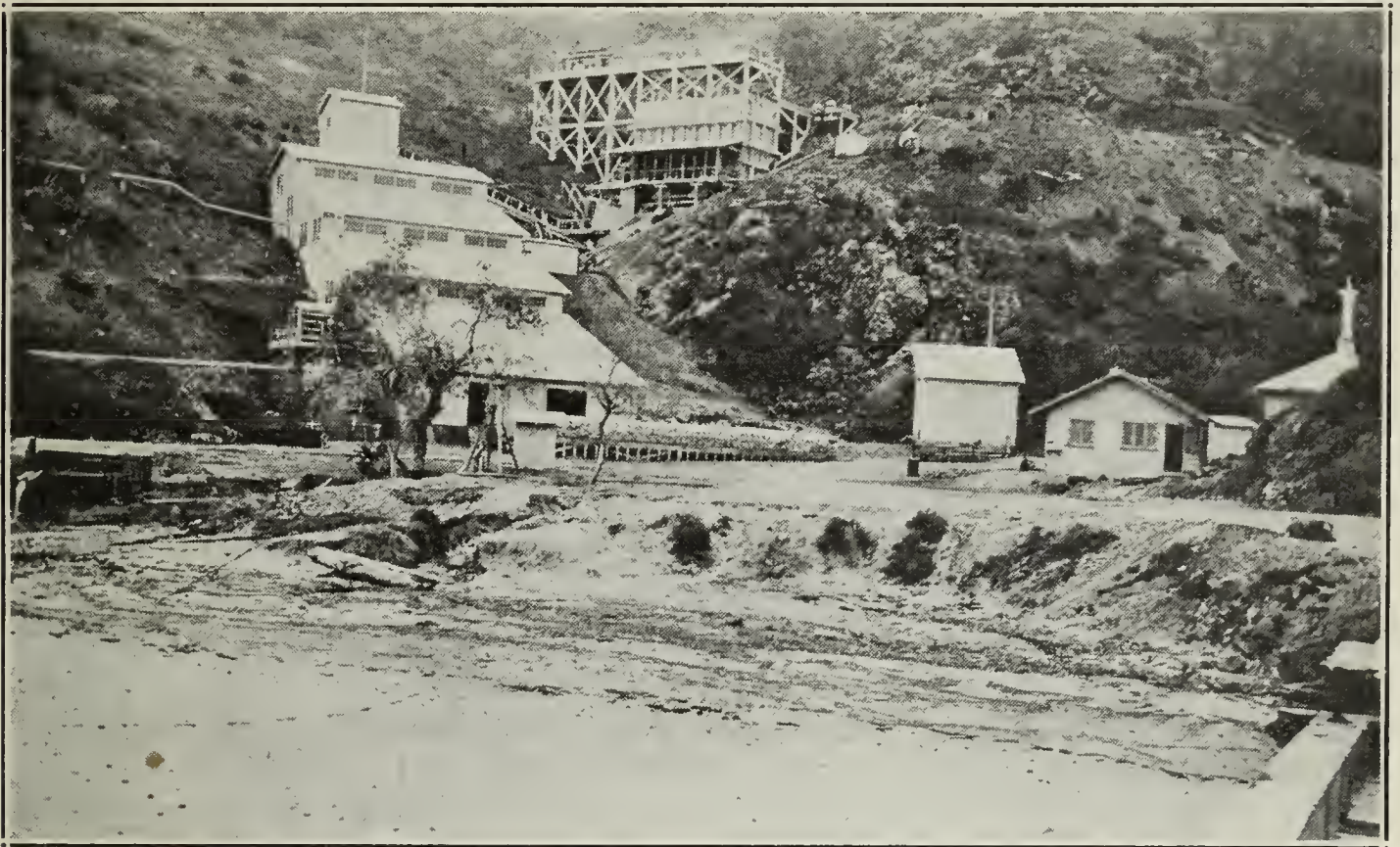
² State Mineralogist's Report XI, p. 343; XIII, p. 204.

³ State Mineralogist's Report XVII, p. 318.

average width of 25 feet. Development consists of a 3-compartment vertical shaft 525 feet deep, with levels driven on the vein at 400 and 500 feet. The upper ore-shoot was worked through a tunnel and winze to the 400-foot level. The total amount of underground workings amounts to 5000 feet. The daily production of the mine when visited was 40 tons per 24 hours. The ore from storage bins at mine is transported over an aerial tram a distance of 2 miles to storage bins at White's Landing, where the ore is treated in a 100-ton flotation plant.

Equipment consists of 75-h.p. double-drum electric hoist, Imperial type XRB, Ingersoll-Rand compressor driven by 100-h.p. motor, blacksmith and carpenter shop. Electric power from main power plant at Avalon.

Bibl: State Mineralogist's Reports X, pp. 279-280; XXIII, p. 33.



Storage bins and 100-ton flotation plant, Santa Catalina Island, California.

Denver-Indicator Group. (Copper, Lead-Zinc.) This group of claims is located in Pacoima Canyon, 12 miles northeast of San Fernando. Elevation 2610 feet. Owner, Denver Mining and Milling Company; W. S. McGrew, president, National Bank Building, San Fernando. The ore is a complex sulphide, carrying massive pyrrhotite, chalcopyrite, galena and sphalerite, with values in gold and silver.⁴

Bibl: State Mineralogist's Report XVII, p. 318.

Kelsey Mine. (Lead-Silver.) It is situated 5 miles north of Azusa, in T. 2 N., R. 9 W., S. B. B. and M., in Silver Mountain Mining District. Elevation 3000 feet. It comprises 4 patented claims. Owner, T. H. Knapp and associates, of Azusa, California. Under option to J. C. Jens, Los Angeles.

The vein, 4 feet wide, occurs along a fault in schist and hornblende gneiss. The strike of the vein is north with a dip to the east. Workings caved. Mr. Jens has located 8 claims south of the Kelsey Group,

⁴ See Copper, page 288, of this report.

on the O. K. Vein. Development consists of 2 tunnels 150 and 200 feet in length. The occurrence of cobalt has also been noted in the ore.

Bibl: State Mineralogist's Report XI, p. 245.

Lost Treasure Mine. (Silver.) This property is situated 6 miles northeast of Azusa in San Gabriel Canyon. Holdings comprise 4 claims. Owners, Messrs. Holcomb, Barber and Fairs, Azusa, California. Prospect.

Bibl: State Mineralogist's Report XVIII, p. 422.

Renton Vein Mine. (Lead-Silver-Zinc.) It is located 2 miles southeast of Avalon, in Renton Canyon, on Santa Catalina Island. Elevation 700 to 1100 feet. Owner, Santa Catalina Island Company; William Wrigley, Jr., president; D. M. Renton, vice president and general manager; David Fleming, secretary; E. H. Pattison, consulting engineer.

Five parallel veins occur in andesite. These veins strike east and dip 60° north, and vary in width from 4 to 6 feet. The ore is sphalerite and galena with silver values. It carries 8 to 12% zinc, $1\frac{1}{2}$ to 2% lead, with values in silver.

Development consists of 4 tunnels on the Renton vein. No. 1 Tunnel is 200 feet, No. 2 Tunnel is 225 feet. No. 3 Tunnel is driven northwest as a crosscut 645 feet to vein, with drift on the vein 130 feet. No. 4 Tunnel, the main working tunnel, is driven south as a crosscut 400 feet to the vein, with drift on the vein of 150 feet, developing a shoot of ore 130 feet in length with an average width of 6 feet. Two other tunnels are being driven on parallel veins at a lower elevation. The ore from these workings is trammed through tunnel No. 4 to storage bins, from which it is transported by aerial tram 3700 feet to a storage bin at Pebble Beach, which has a capacity of 225 tons. Twenty men are employed.

Quarry Mine. (Lead-Silver-Zinc.) It is located on Santa Catalina Island west of the rock quarry, $1\frac{1}{4}$ miles southeast of Avalon and southwest of Pebble Beach. Elevation 300 feet. Owner, Santa Catalina Island Company; William Wrigley, Jr., president; D. M. Renton, vice president and general manager; David Fleming, secretary; E. H. Pattison, consulting engineer.

The vein is exposed along the face of the rock quarry. It strikes east and dips 70° south, in andesite. A series of north and south shear zones cut off the ore-shoot but do not displace the vein to any extent. A tunnel has been driven east 489 feet on the vein. At 310 feet from portal, a winze has been sunk on the vein to a depth of 250 feet. Two levels 85 feet apart have been driven from the winze on the vein, each 350 feet in length. The ore-shoot developed is 150 feet in length and has an average width of 4 feet. The ore mined carries 9% zinc, $1\frac{1}{2}$ to 2% lead and 3 oz. in silver per ton.

The ore from mine bins is hauled by truck to main storage bins at Pebble Beach. From these bins the combined ore from Renton Vein Mine and Quarry Mine is loaded onto a barge having a capacity of 250 tons by a system of belt conveyors. The ore barge is towed by tug to the 100-ton flotation mill at White's Landing.

Mill: The flotation mill at White's Landing has a capacity of 130 tons per twenty-four hours. The combined ore from Black Jack, Renton Vein and Quarry mines is treated by concentration and flotation. Mill equipment consists of Blake crusher; Marcy ball mill; Dorr simplex classifiers; two Devereaux agitators; four 12-foot K & K flotation machines; three 6-foot K & K flotation machines; 4 Cottrell tables; Wilfley pumps; 2 Dorr thickeners; 2 Oliver filters. Water supply for mill is pumped from the ocean. Electric power for operating the mill is secured from the main power plant at Avalon. The ore treated at present writing carries 7.2% to 8.7% zinc; 1.5% to 3.5% lead and 3.5 oz. per ton in silver, the product produced being 15 tons of zinc concentrates per 24 hours, carrying 45% zinc, 3.2% lead and 11.5 oz. silver per ton. The lead concentrate produced amounts to 3 tons per 24 hours, carrying 55% lead, 8% zinc and 93 oz. silver per ton. The tailings carry 2.1% zinc, 0.2% lead and 0.9 oz. silver. Average recovery made is 80% of the zinc and 88% of the lead and 80% of the silver. The zinc concentrates are shipped to Belgium and the lead-silver concentrates to the American Smelting and Refining Company's smelter at Selby, California. Thirteen men are employed in the mill.

Bibl: State Mineralogist's Report XXIII, p. 36.

Silver King Mine. (Lead-Silver.) It is located in Texas Canyon, 12 miles northeast of Saugus, a station on the Southern Pacific Railroad. Holdings comprise 18 claims. Elevation 2350 feet. Owner, W. H. Cruzan, Newhall, California.

A vein of quartz 2 feet wide strikes east and dips 53° north. The quartz is mineralized with galena and said to carry 10 to 30 oz. in silver per ton.

Workings consist of glory hole and two tunnels, the upper tunnel 250 feet in length. From this level a raise connects with glory hole. At a lower elevation, a tunnel has been driven 100 feet east parallel to the vein in the footwall. One man is employed.

Sunshine Mine. (Gold-Silver.) It comprises 10 claims located in Bouquet Canyon, 17 miles from Saugus. Owners, Messrs. Christman, Fuller and Meuer, Los Angeles. Vein of quartz 20 feet wide. Development consists of shaft 50 feet deep.

Bibl: State Mineralogist's Report XVIII, p. 422.

Victoria Mine. (Lead-Silver.) It is located 6 miles northeast of Azusa, in San Gabriel Canyon. Elevation 3000 feet. Idle for years. Formerly operated by Sierra Madre Silver Mining Company, Azusa, California.

Bibl: State Mineralogist's Report XI, p. 245.

MANGANESE.

Amargosa Group of Claims. The deposit is situated 5 miles by road west of Palmdale, in T. 6 N., R. 12 W. and R. 13 W., S. B. B. and M. Holdings comprise 9 claims.

Irregular lenses of manganese ore occur along silicious outcrops in schist. Outcrops of manganese ore can be followed for a distance of

several hundred feet. The width of ore exposed varies from 2 to 5 feet. The ore carries a high percentage of silica.

Developments consist of a number of opencuts, tunnels and shallow shafts. The deposit was operated by the Llewellyn Iron Company in 1917. Idle.

Bibl: State Mineralogist's Report XVII, p. 320.

MOLYBDENUM.

Manzanita Mine. It comprises two claims located in Lang Canyon, in T. 2 N., R. 12 W., S. B. B. and M., 6 miles north of Altadena. Elevation 3500 feet.

Molybdenite is found here associated with copper in a quartz vein that occurs in granite, which strikes northwest. Idle.

PETROLEUM AND NATURAL GAS.

Los Angeles County ranked first in the state in the production of oil and gas for the year 1926. The production of petroleum amounted to 105,826,337 bbl., valued at \$174,084,324. The production of natural gas amounted to 91,054,793 M cu. ft., valued at \$8,965,307. For detailed description of oil fields see bulletins Nos. 69 and 89, 'Petroleum Resources of California,' also annual reports of the State Oil and Gas Supervisor, issued by the State Mining Bureau.

NONMETALLIC MINERALS.

The nonmetals are commercially the most important among the mineral products of the county. In 1926 their aggregate value was over \$11,000,000. The rapid increase in growth of the cities of Los Angeles, Long Beach and Pasadena, and surrounding towns, has developed a great demand for materials employed in the building trades and all important deposits of minerals used in the manufacture of structural materials have been energetically developed and worked.

BARYTES.

San Dimas Canyon Barytes Deposit. It is situated 8 miles northwest of San Dimas, in Sec. 23, T. 1 N., R. 9 W., in the west fork of San Dimas Canyon.

An outcrop of barytes occurs on the west side of the canyon. The general strike of the outcrop is northeast, with slight dip to the southeast. This outcrop is about 50 feet in length and has a width of 6 to 8 feet. The barytes is white in color and said to carry 85% barium sulphate. Idle.

Bibl: State Mineralogist's Report XVII, p. 317.

BORAX.

There was a large deposit of colemanite in Los Angeles County, 5 miles north of Lang, in Tick Canyon. Elevation 2300 feet. Holdings comprise some 1200 acres. This deposit was formerly worked by the Sterling Borax Company, of Los Angeles, but it has been closed down

for several years and all equipment has been removed from the property. Presumably the profitable material has been exhausted.

The colemanite beds strike east and dip 70° to 80° south. These beds occur in tilted beds of clay shale which in places are covered with a flow of andesite. The beds are 30 to 50 feet in thickness. The deposit has been worked through a vertical shaft and evidently mined for several thousand feet in length. The calcium borate was formerly transported by narrow-gauge railroad to Lang, a station on the Southern Pacific Railroad. This road has been torn up.

Bibl: State Mineralogist's Report XV, pp. 480-481.

CLAYS.

There are no deposits of high-grade clays in Los Angeles County, but throughout its area there are clays mixed with sand and containing numerous inclusions of pebbles, which are suitable for the manufacture of common brick and tile. No high-grade clays are produced in the county, those used being shipped in from Amador, Placer, Riverside and San Diego counties. No description of the deposits or the manufacturing plants will be attempted in this report for the reason that Prof. W. F. Dietrich, of the Ceramic Department, Stanford University, in a report on the 'Clay Resources of California,' which is now in preparation by the State Mining Bureau as a separate bulletin, will describe the deposits and plants in detail.

Among the leading manufacturers of brick in Los Angeles County are the following:

Acme Brick Company, Hill Street Building;
Atlas Fire Brick Company, 601 South Boyle;
City Brick Company, 85th Street and Vermont Avenue;
Davidson Brick Company, 4701 Floral Drive;
K & K Brick Company, Merchants National Bank Building;
Long Beach Brick Company, Long Beach;
Los Angeles Brick Company, 1078 Mission Street;
Los Angeles Pressed Brick Company, 621 South Hope Street;
Pacific Clay Products Company, 1151 South Broadway;
St. Louis Fire Brick and Clay Company, 3464 East Ninth Street;
Simons Brick Company, 125 West Third Street;
Southgate Brick Company, Southgate;
Standard Brick Company, Stimson Building.
Western Brick Company, Lankershim Building.

The following are the manufacturers of pottery ware in the county:

American China Company, W. N. Reeves, president, 2304 East 52d Street;

K. & M. Pottery, M. C. Myers, president, 2318 East 52d Street;

Poxon Pottery, G. J. Poxon, president, 2300 East 52d Street.

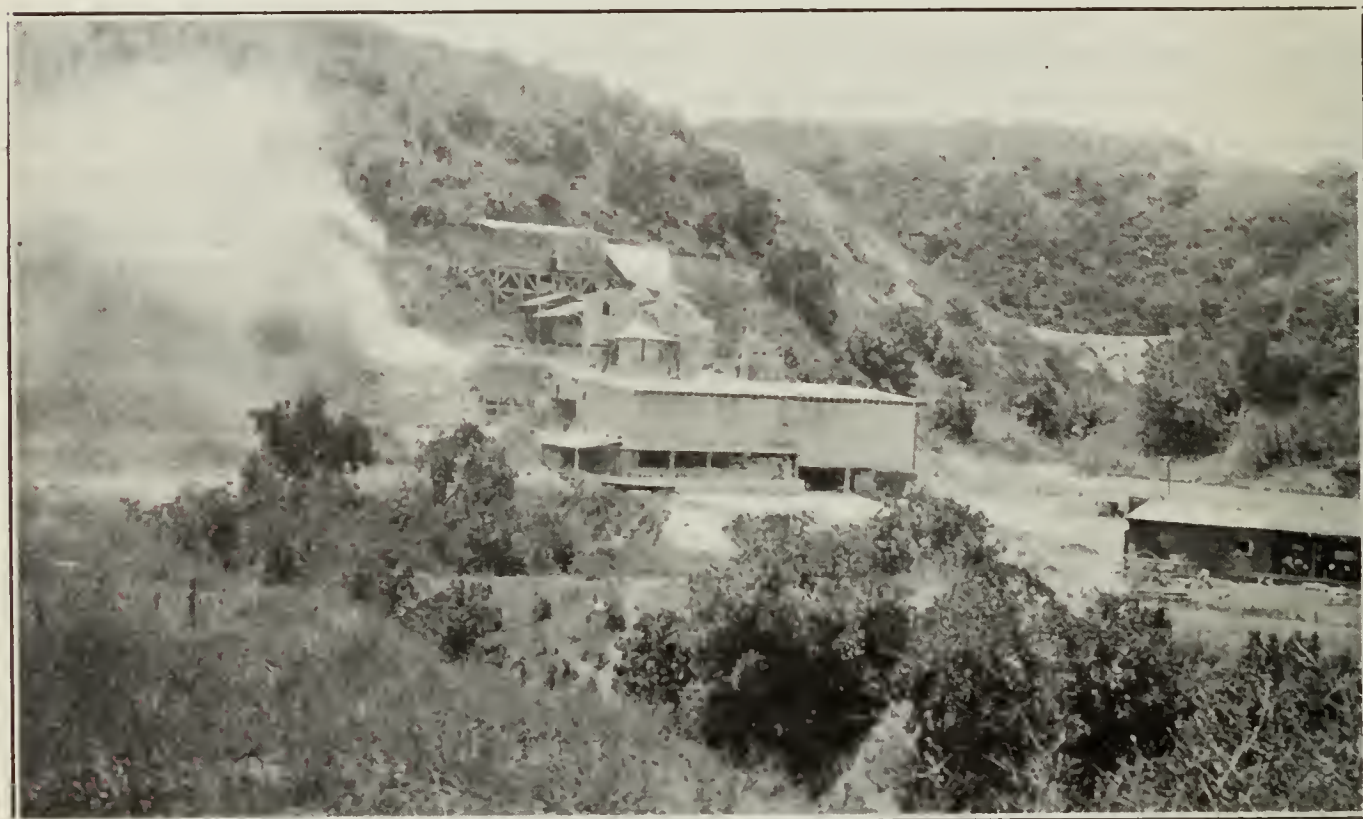
DIATOMACEOUS EARTH.

Deposits of this important material occur in Los Angeles County, but the only commercial production is from a deposit located in the San José Hills, east of Covina.

Featherstone Insulation Company's Deposit. It is located in T. 1 S., R. 9 W., S. B. B. and M., $2\frac{1}{2}$ miles east of Covina on the north slope of

the San José Hills. Elevation 750 feet. Holdings comprise 500 acres. Owner, the Featherstone Company, 911 Mateo Street, Los Angeles. Robert Burhans, Jr., president; R. W. Cole, secretary.

These hills in which the Featherstone deposits are located are made up entirely of diatomaceous earth and lie in two gentle folds that terminate abruptly against an almost vertical fault, which marks the eastern boundary of the deposit. Here No. 3 Quarry, which is located on the south slope of the hill, has exposed the vertical strata of diatomaceous earth that strike east. These beds are estimated to be 700 feet in depth. The quarry exposes a face of material 200 feet in width. The material mined from this quarry is hauled by truck to the grinding plant, a distance of one mile. To the west and on the north slope, the beds of diatomaceous earth lie horizontal and in places are covered with a capping of Fernando conglomerate. The underlying material of the entire deposit is buff-colored clay, interbedded with streaks of

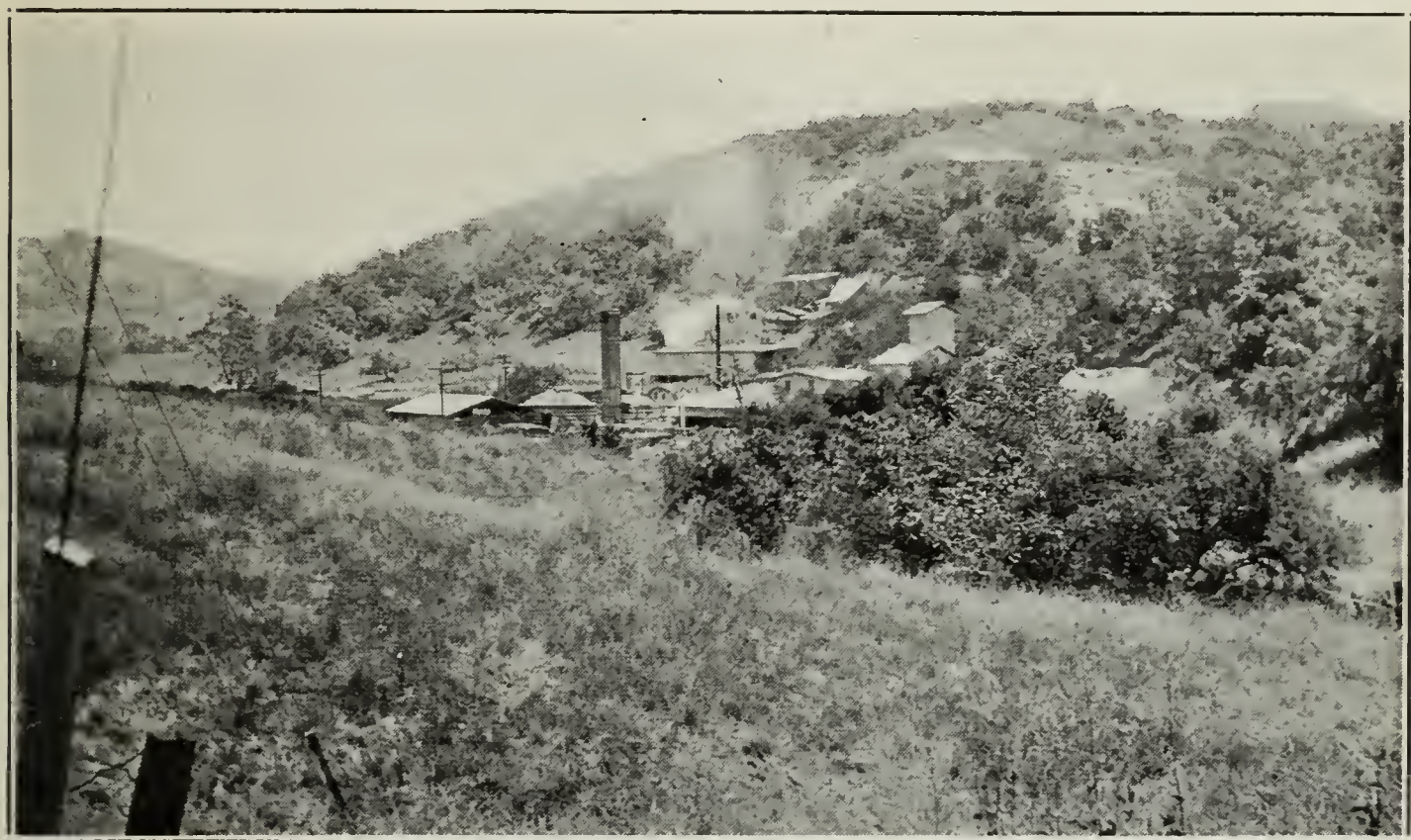


Featherstone Insulation Company's plant, Covina, California.

sandstone and flint. The line between the buff-colored clay and the beds of diatomaceous earth is clearly defined, there being an abrupt change from the clay to the white diatomaceous earth that forms the overlying deposit of which more than 300 feet has been exposed by erosion. Of this mass, the lower white beds, which are very pure, grade gradually into the upper gray beds, which contain less silica and more lime and alumina. The beds at the eastern end of the deposit have been exposed on the north slope of the hill by quarries and opencuts. These beds have a thickness of 50 to 125 feet. Quarry No. 1 exposes these horizontal beds of diatomaceous earth for a distance of 500 feet in width. The beds at this point are about 100 feet thick.

The material from quarry No. 2, which is located one-quarter of a mile west of the plant on the north slope of the hill, is mined for filtration of gasoline. From the floor of this quarry a shaft 45 feet deep has been sunk through the beds of diatomaceous earth to the underlying beds of buff-colored clay shale. The beds of diatomaceous earth

are 30 feet thick, then 10 feet of sand overlies the clay. A tunnel has been driven south 300 feet to the clay shale. The clay is being mined for the manufacture of brick and tile. The material from the different quarries is hauled by trucks to a grinding plant having a capacity of 25 tons per day. The material first passes over a grizzly, then to roll type of crusher. From crusher it goes to direct rotary dryer and then to a Gruendler mill. The ground product from this mill is conveyed to cyclones and bag house. The products produced are high temperature insulation materials, concrete admixture (for use in cement to increase the flowability of cement, 3 pounds of diatomaceous earth to 100 pounds of cement). The clay which is mined from the tunnel is hauled by truck to a brick and tile plant that consists of tile and brick machines and two round kilns. Capacity of plant is 150,000 tile per month and 150,000 insulation brick per month. Natural gas is used for fuel. Thirty-five men are employed.



Quarries and plant of The Featherstone Insulation Company, Covina, California.

Palos Verdes Ranch Deposits. Several exposures of diatomaceous earth occur on the east slope of the San Pedro Hills, on the Palos Verdes Ranch.

Santa Catalina Island Deposits. Diatomaceous earth occurs on Santa Catalina. The beds are said to be 75 feet thick. Other deposits occur in the *Santa Monica Mountains*, the most extensive exposure being near Point Durma, northwest of Santa Monica.

Bibl: State Mineralogist's Reports XII, p. 406; XIII, p. 643; Bull. 38, p. 363.

DOLOMITE.

Deposits of dolomite occur on the west slope of the San Gabriel Mountains, in Secs. 13, 17, T. 3 N., R. 15 W. and in Secs. 7 and 18, T. 3 N., R. 14 W., S. B. B. and M., between Pacoima Canyon and Grapevine Canyon, north of San Fernando.

Baughman Dolomite Deposit. It is situated in Secs. 7 and 18, T. 3 N., R. 14 W., S. B. B. and M., on a ridge north of Pacoima Creek, 5 miles north of San Fernando. Elevation 3000 feet. Owner, Will Baughman, Los Angeles. Holdings consist of 40 acres.

A belt of white crystalline dolomite occurs in the granite that strikes east and dips 50° north. The exposure is about 300 feet in width and about 3000 feet in length.

Ramelli Dolomite Deposit. The deposit is located on the west slope of the San Gabriel Mountains, in Sec. 17, T. 3 N., R. 15 W., S. B. B. and M., 4 miles northeast of San Fernando. Elevation 2200 feet. Holdings comprise two claims, 40 acres. Owners, Frank Ramelli and Edward Oviatt, of Van Nuys.

White, crystalline dolomite occurs in granite with a general easterly and westerly course and dip of 45° to the north. The exposure is from 200 to 500 feet in width and can be traced for the full length of two claims.

Bibl: State Mineralogist's Report XIX, p. 165.

San Fernando Company's Dolomite Deposit. It is located in Sec. 13, T. 3 N., R. 15 W., S. B. B. and M., 4 miles north of San Fernando and on a ridge east of Pacoima Canyon. Elevation 3000 feet. The exposure of white, crystalline dolomite is several hundred feet wide and 2000 feet in length. The dolomite occurs in granite and strikes east with a dip to the north.

FELDSPAR AND SILICA.

There is an extensive belt of labradorite, lime-soda feldspar, containing a high aluminum content, that extends east from Lang on both sides of Soledad Canyon to Ravenna, a distance of about 12 miles. The most extensive deposits of this material are located south of Soledad Canyon for a distance of about 2 miles. This alumina-silicate rock probably could be used in the manufacture of high-grade refractory products, such as porcelain, pottery, electric insulators, spark plugs, sanitary ware for plumbing and cleanser compounds. Silica occurs quite abundantly in the county and a number of quartz outcrops in the vicinity of Acton have been worked in the past, but at present writing none of the deposits are being worked.

The following is an analysis of the alumina-silicate rock made by the C. W. Hill Company, of Los Angeles:

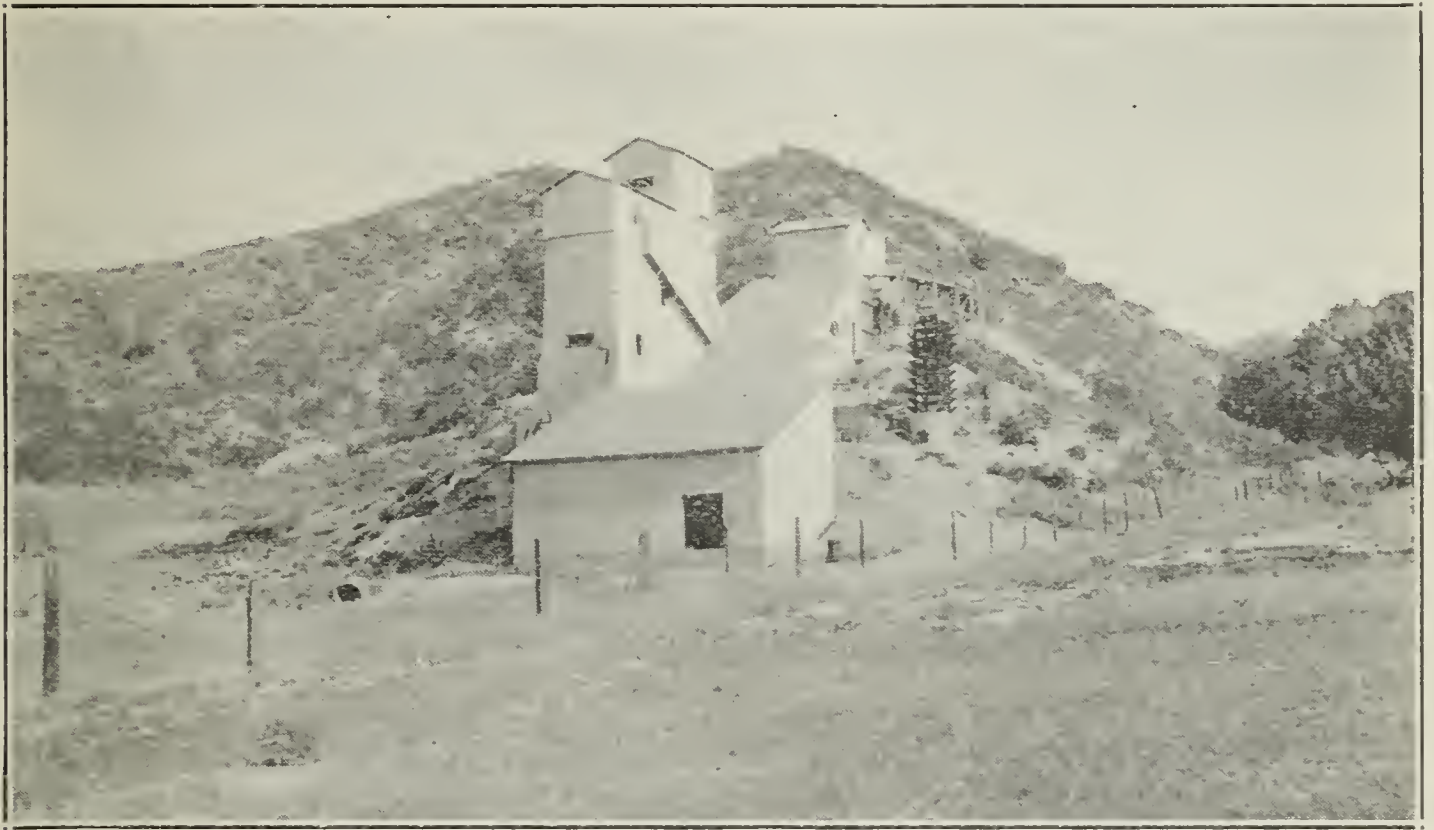
Silica	58.10%
Alumina	28.27%
Ferric Oxide	1.03%
Lime	8.60%
Magnesia	0.54%
Potash	1.60%
Soda	0.82%
Moisture	0.10%
Loss in ignition	0.55%
	<hr/>
	99.61%

Deposits.

Caliproducts Company's Deposit. (Feldspar-Silica.) The deposit is located in Sec. 15, T. 4 N., R. 13 W., S. B. B. and M., one mile south of Ravenna, a station on the Southern Pacific Railroad. Elevation 2650 feet. Holdings comprise 200 acres. Owner, Lenardo Ruiz, of Acton. Under option to the Caliproducts Company, Ralph C. McInerny, president, 1009 Spring Arcade Building, Los Angeles.

Development consists of several tunnels and opencuts. The material was mined through a tunnel 20 feet in length, with laterals driven east and west along the strike of the labradorite. The material is trammed in 1-ton cars to a 100-ton grinding plant, where it is crushed, screened, reground and rescreened into a finished product for the local market at Los Angeles.

There are millions of tons of soda-lime-feldspar rock exposed on the property. The plant was operated during 1925 and some material shipped to glass and pottery manufacturers.



100-ton grinding plant, Caliproducts Company, Ravenna, California.

For the manufacture of glass, the iron should be eliminated. The presence of iron has so far been a drawback to its use. With the limited supply of high-grade potash feldspar in California, there is a possibility that these deposits will be of commercial importance in the near future. Two men are employed at the mill.

Chicago-Pacific Deposit. (Feldspar and Silica.) This deposit is located in a range of hills north and south of Soledad Canyon, in Secs. 8, 9, 15, 16 and 17, T. 4 N., R. 14 W., S. B. B. and M., 11 miles east of Saugus and one-quarter of a mile north of Lang, a station on the Southern Pacific Railroad. Holdings comprise 13 claims. Owners, J. P. Monahan and J. G. Krown, Homer Laughlin Building, Los Angeles.

It is a massive deposit of labradorite (soda-lime-feldspar), containing a high aluminum content, which, according to analysis, should probably be satisfactory for the manufacture of refractory products.

The low iron content suggests its use for high-grade Portland cement and it also might be used as a paint filler and for cleanser compounds. The general strike of the formation is east and it can be followed from Lang to Alpine Siding, on the Southern Pacific Railroad, a distance of two miles. It is about two miles in width and occurs in contact with schist, which lies to the south of the labradorite. Idle.

Duncan Feldspar Deposit. (Feldspar-Silica.) It is located in Secs. 14 and 15, T. 4 N., R. 13 W., S. B. B. and M., one mile south of Ravenna, a station on the Southern Pacific Railroad. Elevation 2500 feet. Holdings comprise 160 acres of patented land. Owner, Harry Duncan, Black Building, Los Angeles.

An extensive deposit of aluminum-silicate rock covers this area. It is reported that in 1918, 2000 tons of this material was shipped from the deposit to Los Angeles for the manufacture of electrical insulators. Idle.

Gates Chemical Company's Deposit. (Feldspar-Silica.) This deposit of labradorite (soda-lime-feldspar) is located near Alpine Siding, on the Southern Pacific Railroad, in Soledad Canyon, 2 miles east of Lang. Elevation 1950 feet. Holdings comprise seven claims, in Sec. 15, T. 4 N., R. 14 W., S. B. B. and M. Owner, Gates Chemical Company, E. S. Gates, president; M. L. Gates, secretary. Offices, Denver, Colorado. Local offices, 1204 West Seventh Street, Los Angeles. This is a large deposit of alumina-silicate rock, white in color, and appears to have a low iron content.

Development consists of a quarry 150 feet in length with a bank 20 feet in height, which is located just south of Alpine Siding. The company proposes to install a crushing and screening plant near the site of the quarry. At present there is a loading platform and warehouse at Alpine Siding. The material is now being shipped to the company's plant at Pacoima, California, where it is ground and screened and a product produced known as Gates' Cleanser. Several men are employed.

Stanley Alumina-Silicate Deposit. (Feldspar-Silica.) It is a large deposit of labradorite (soda-lime-feldspar) situated in Secs. 26 and 28, T. 4 N., R. 14 W., S. B. B. and M., 4 miles southeast of Lang. Elevation 3000 feet. Holdings comprise 160 acres. Owner, George Stanley, of Los Angeles.

The belt of labradorite strikes east and the material is white in color, containing a high aluminum content, with low iron content.

Silica Mining and Products Company's Deposit. (Feldspar-Silica.) This deposit of silica and feldspar is located one-half mile northeast of Acton, a station on the Southern Pacific Railroad. Elevation 3200 feet. Holdings comprise two claims. Owner, Silica Mining and Products Company, Los Angeles. S. M. Clayman, president.

A vein of silica and feldspar 25 feet wide occurs in granite. It strikes northeast and dips 60° northwest. Workings consist of an open-cut and an incline on the vein for a distance of 35 feet. The silica is on the footwall side of the vein, with feldspar on the hanging-wall. The quartz is clear white, containing occasional streaks of hematite and bunches of muscovite. The feldspar is a pink orthoclase, of good quality.

Equipment consists of loading bins, hoist, Rix portable compressor and cars. Shipments of feldspar and silica were made from the deposit in 1926. Idle.

GRAPHITE.

Commercial deposits of crystalline graphite occur in Los Angeles County in Kagel Canyon, east of Fernando, in San Francisquito Canyon, 18 miles northeast of Saugus and in the Verdugo Hills, 2½ miles northwest of Montrose. In these deposits the graphite occurs in crystalline flakes disseminated through a schist. According to E. S. Bastin, of the United States Geological Survey, the percentage of graphite in the California deposits appears to be nearly twice that of the eastern deposits of flake graphite, which are located in New York, Pennsylvania and Alabama. The flakes in the California graphite schist are much smaller than those in the eastern states, most of them not exceeding 0.25 millimeter in diameter. Some production has been made from all the deposits mentioned, but considerable difficulty has been encountered in making a complete separation of the graphite from the gangue materials. The only deposit under operation at the present time is the Standard Graphite Company's property located in the Verdugo Hills. The graphite concentrate from these deposits is sufficiently rich in graphite to serve for foundry facings, boiler compound and as paint pigment.

Kagel Canyon Graphite Deposit. The deposit is located on the western slope of the San Gabriel Mountains, in Kagel Canyon, 8 miles east of San Fernando. Holdings comprise 5 claims. Elevation 2400 feet. Owner, Los Angeles Graphite Company, Albert Maltman, agent, Grant Building, Los Angeles. The deposit was formerly worked by the American Graphite Company, of Decatur, Illinois.

The graphite occurs disseminated in very small flakes through an outcrop of schist 10 to 20 feet wide. Nearly all the graphite is in flakes 0.25 millimeter or less in diameter. The other minerals in the graphite schist are quartz, feldspar and small quantities of pyrite. The ore is reported to carry from 7% to 15% graphite. The vein can be traced for a distance of 4000 feet and outcrops through 3 full claims. Its course is N. 30° W. and dips 70° east.

Development consists of tunnels and opencuts on the vein.

Equipment consists of 50-ton concentration mill, consisting of crusher, rolls, Marks pulverizer, tube mill, two Allingham flotation machines and Oliver filter. Idle.

Bibl: State Mineralogist's Report XVII, p. 318.

San Francisquito Canyon Graphite Deposit. It is located in Secs. 11 and 12, T. 6 N., R. 15 W., S. B. B. and M., 18 miles northeast of Saugus, in a branch of San Francisquito Canyon. Holdings comprise 9 claims. Owner, California Graphite Company. O. M. Souden, president; A. B. Plumb, secretary, Los Angeles. The property has not been operated for several years.

The vein of graphite schist occurs in granite. It strikes northeast and can be traced along its outcrop for a distance of 6000 feet. The vein is 8 to 25 feet wide. Crystalline graphite occurs disseminated in the schist in very small flakes. Analyses of the graphite schist made by the U. S. Geological Survey ran from 7% to 17% graphite.

Developments consist of a number of tunnels and opencuts along the outcrop. Idle.

Bibl: State Mineralogist's Reports XV, pp. 501-504; XVII, pp. 318-319.

Verdugo Mountain Graphite Deposit. It is situated 12 miles northeast of Los Angeles and $2\frac{1}{2}$ miles northwest of Montrose, in Sec. 29, T. 2 N., R. 13 W., S. B. B. and M., on the Hostetter Ranch. Elevation 1500 feet. Owner, J. E. Hostetter, Los Angeles. Under lease to Standard Graphite Company, Glendale, California. L. S. Freeze, president; Dr. Sutton, secretary. This company has subleased the property to E. B. Babbit, of Santa Barbara, California. W. O. Kunkle, superintendent.

The deposit occurs as a vein of graphite schist in granite, on the northeast slope of the Verdugo Hills. The vein strikes S. 20° W. and dips 50° SE., and is 7 to 30 feet wide. The vein has been exposed in two places; in an opencut about 130 feet above the floor of the valley and at a higher elevation on the hillside by a shallow shaft.

Developments consist of an opencut, and 70 feet below this opencut a tunnel is driven southwest a distance of 60 feet, exposing a vein 5 feet wide which dips 45° southwest. The graphite is crystalline but in small flakes, with very little or no mica associated with it, the gangue being quartz and feldspar. The graphite schist carries from 10% to 15% graphite. The ore is being mined from the opencut, from which it is being trammed in cars to mill bins. The mill has a capacity of 25 tons per 24 hours. From bins the ore is fed to hammer type of crusher, then goes to 4' x 4' Marcy ball mill, in closed circuit with Atkin's classifier. It is then treated by concentration and flotation, there being one Wilfley table; one 4-cell K & K rougher, and two 3-cell K & K cleaner machines. The float concentrate goes to 3' x 4' Oliver filter, the cake from Oliver filter to 2 rotary dryers (20" diameter by 21' in length), then by screw conveyor to tube mill, where it is ground to pass to minus 100-mesh, of which 80% will pass 200-mesh. The product from tube mill is elevated by bucket elevator to storage bin. From bin the material is conveyed to two McKain-Reel screens, where screened so 90% will pass 100-mesh, the 10% oversize being returned to the tube mill. The minus 100-mesh product goes to bin, from which it is fed to barrel loading machine. The company is producing four different products for paint stock, which are as follows:

28% to 34% carbon,
35% to 40% carbon,
40% to 45% carbon.

The foundry facing product is classified in the following grades:

No. 1 46% to 48% carbon.
No. 2 49% to 54% carbon.
No. 3 55% to 60% carbon.

The mill is at present producing 4 tons of product per 24 hours. Twelve men are employed.

Bibl: State Mineralogist's Reports XV, p. 504; XVII, p. 319.

Other deposits of graphite occur in the county but they have not yet been developed commercially. A deposit of crystalline graphite occurs in T. 7 N., R. 15 W., S. B. B. and M., near Elizabeth Lake. Graphite occurs in Tujunga Canyon and it also is found at the head of San Francisquito Canyon in S $\frac{1}{2}$ of Sec. 11, T. 7 N., R. 16 W., S. B. B. and M. The vein crosses Charlie Canyon.

GYPSUM.

Deposits of this material occur in the county near Palmdale, near Lang in Sec. 30, T. 5 N., R. 14 W., S. B. B. and M. and at the head of San Francisquito Creek, 13 miles from Casteca. No commercial production has been made from the above mentioned deposits in recent years.

Palmdale Gypsum Deposits. These are the most important gypsum deposits in the county and they were formerly worked by the Alpine



Fossil Beds, San Pedro Hills, Torrance Lime and Fertilizer Company.

Plaster Company, of Los Angeles. Owner, New Alpine Gypsum Company; Kendall Delaney, 720 North Spring Street, Los Angeles.

The gypsum outcrops for several miles east and west of Palmdale, in the low foothills along the south side of Antelope Valley, interstratified with conglomerate, sandstone and shale. The general dip of the strata is to the south. Part of the gypsum occurs in fibrous layers $\frac{1}{8}$ " to $\frac{1}{2}$ " thick, alternating with thin layers of clay and shale. In other places, along the outcrop, the gypsum is more massive, shows little crystallization and contains more or less white and yellow clay diffused through its mass. A dozen or more small quarries have been opened up along the deposit. The beds worked varied from 2 to 30 feet in thickness. The company has a small mill located at Palmdale, where the gypsum was formerly manufactured into plaster. Idle.

Bibl: State Mineralogist's Reports XI, p. 248; XII, p. 324; XIII, p. 504; XV, pp. 504-506; Bull. 38, pp. 284-286.

LIME.

Fossiliferous deposits of lime occur in the county in the San Pedro Hills on the Los Palos Verdes Ranch.

Torrance Lime and Fertilizer Company. Frank Samons, president; Richard C. Kite, secretary. Offices, Torrance, California. Operating the D. M. S. and B. fossil beds, which are located on the east slope of the San Pedro Hills, 2 miles southwest of Lomita. Holdings comprise 38 acres.

These fossil beds strike N. 60° W. and dip 30° NW. and are 30 feet thick, covered in places with 12 feet of adobe soil. The fossiliferous lime carries 70% calcium carbonate. The following is an analysis made by Smith-Emery Company, Chemists, of Los Angeles:

Iron oxide (Fe_2O_3)	0.57%
Alumina (Al_2O_3)	0.74%
Calcium oxide (CaO)	49.21%
Magnesium oxide (MgO)	2.26%
Alkalies (K_2O , Na_2O)	0.44%
Carbon dioxide (CO_2)	39.23%
Sulphuric anhydride (SO_3)	0.13%
Phosphoric anhydride (P_2O_5)	0.73%
Moisture (below 105° C.)	0.17%
Combined water (over 165° C.)	2.89%
Acid insoluble matter	3.63%

The presence of phosphate in this deposit of lime makes the material valuable for use as fertilizer. The material is mined from an open pit 300 feet in length and 200 feet in width with a bank 60 feet in height. From this pit it is transported by dragline scraper to 100-ton per day crushing and screening plant.

A large tonnage is sold to the Pioneer Compost Company's plant at Harbor City. A considerable tonnage is also sold to citrus fruit growers for use on adobe soils. The low-grade material carrying 15% CaCO_3 is used for road material. Three men are employed.

MINERAL WATER.

There are a number of mineral springs in Los Angeles County, some of which are within the city limits of Los Angeles.

Bimini Springs are located at Bimini Street and Vermont Avenue. Owner, Bimini Water Company. It is used for baths and bottled for sale.

Holly Springs Water Company, 2284 Holly Drive; *Hollywood Medical Springs*, 5633 Melrose Avenue; *Magnetic Spring Water Company*, 936 Palm Avenue, Sherman.

Mohn Mineral Springs, located in Topango Canyon, 10 miles northwest of Santa Monica. Owner, Mohn Mineral Springs Company, 6253 Hollywood, California. Water bottled for sale.

Mountain Spring Water Company, 226 South Avenue 54, Los Angeles. Water bottled for sale.

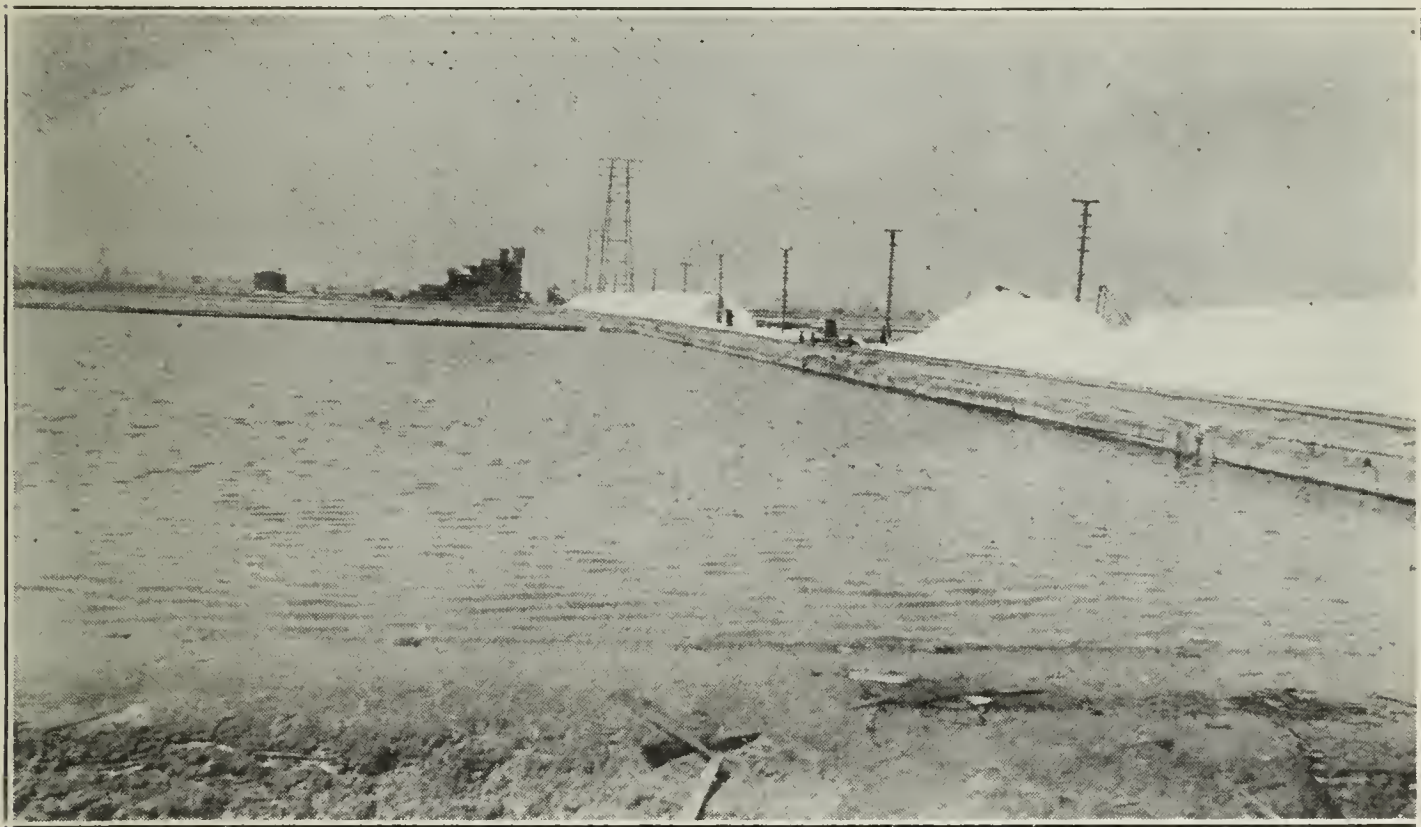
Rose Spring Mineral Water Company, 4835 Pasadena Avenue. The spring is located on Pasadena Avenue, opposite Sycamore Park. Water bottled for sale.

MINERAL PAINT.

Deposits of red and yellow ochre occur on Santa Catalina Island. These deposits are being developed for commercial use by the Santa Catalina Island Company. The principal occurrence is found along the surface outcrops of veins that are being worked for lead-silver and zinc in Renton Canyon.

SOAPSTONE AND TALC.

Deposits of soapstone and talc occur in chloritic schist on both sides of Bouquet Canyon, 13 miles west of Palmdale and 16 miles northeast of Saugus, a station on the Southern Pacific Railroad. A considerable amount of surface prospecting has been done on these deposits but no commercial production has been made in recent years.



Crystallizing ponds and stock piles of salt, Long Beach Salt Company.

For description of the different deposits see page 321 of Report XVII of the State Mineralogist.

There is also an extensive deposit of steatite on Santa Catalina Island, located near the Isthmus, at Empire Landing.

SALT.

There is no source of salt in Los Angeles County except the water of the Pacific Ocean, from which it is extracted by solar evaporation from the sea water west of Long Beach. At present there is only one plant in operation in the county.

Long Beach Salt Company. H. G. Fenton, president; B. S. Hardy, secretary; O. L. Huffine, superintendent. Offices No. 1 Drumm Street, San Francisco.

The plant is situated one-half mile south of the Anaheim Road, between Wilmington and Long Beach. The pond area amounts to

250 acres which has been divided into shallow ponds for evaporation, by the construction of low dams. The water is pumped in from the ocean to the evaporating ponds, from which it flows to twenty crystallizing ponds, (200 feet wide by 250 feet in length by 24 inches in depth). In these crystallizing ponds the salt begins to crystallize out and at 1.252 specific gravity salt of the first quality is deposited, after which the remaining brine known as bittern water is pumped off, new brine from the evaporating ponds is transferred into the crystallizing ponds and thus the process continues until the salt deposit reaches a depth of six inches. When the desired thickness of salt has been deposited, the pond is drained and a crew of men is set to work to harvest the salt. The crystallizing season runs from April 1 to July 1 and the gathering season from September 1 to January 1. The method of harvesting consists of a narrow launder 250 feet in length, containing a screw conveyor, and six men shovel salt into the launder, where it is washed with fresh salt water. The salt is conveyed by screw conveyor to a belt stacking machine which distributes it into piles along the railroad track. From stock piles the crude salt is loaded into a car having a capacity of 5 tons, in which it is transported to the plant. Here the salt is dumped into a hopper, from which it is conveyed by bucket elevator to screens. The screened salt goes to four conical dryers, then elevated to screens, the oversize from these screens going to bins for use as packing salt. The through-size goes to a set of rolls for grinding for table salt. The very coarse salt is used by the packing companies. It also is used in the manufacture of ice cream and in various forms of business in which coarse salt is necessary. The present production is about 10,000 tons per year. Twenty men are employed.

STONE INDUSTRY.

There has been no production of building stone in Los Angeles County during recent years due principally to the development of new methods of construction, as brick, terra cotta, tile and concrete have been extensively substituted for cut stone. Among the building stones occurring in this county are the following: Granite, sandstone, serpentine, volcanic tuff and trachyte.

GRANITE.

Deposits of granite occur in the San Gabriel Range but the outcrops are high and inaccessible. There is a deposit of hornblende biotite granite in Verdugo Canyon, on the Glendale Ranch. The granite takes a very high polish and is very well adapted for monumental work.

SANDSTONE.

Deposits of sandstone occur in the Simi Hills, in Sec. 13, T. 2 N., R. 17 W., S. B. B. and M., $1\frac{1}{2}$ miles west of Chatsworth Station, on the Southern Pacific Railroad.

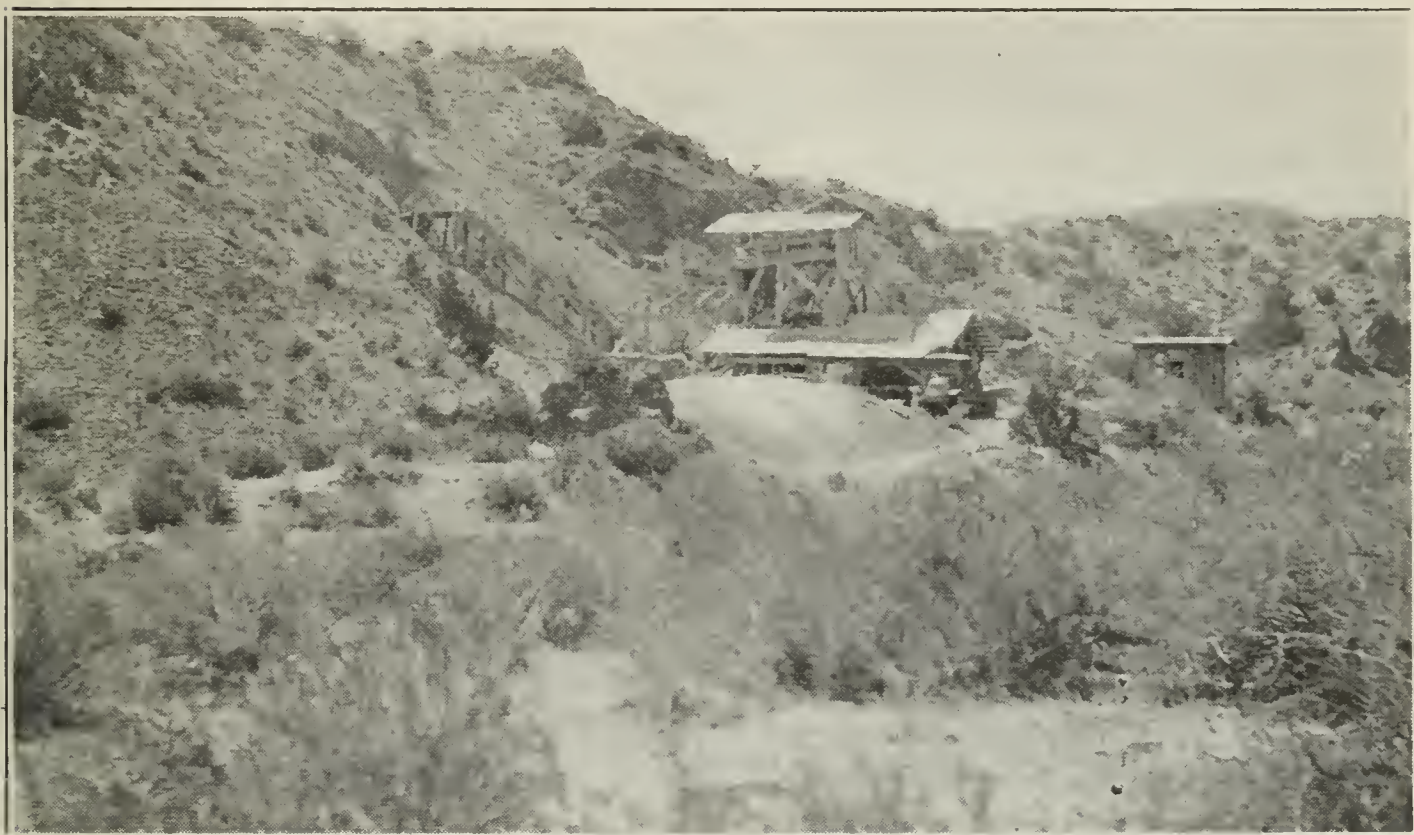
The stone is arkose or feldspathic sandstone, rather fine-grained and heavily bedded. The rock was formerly quarried for the building of the San Pedro breakwater.

SERPENTINE.

A deposit of serpentine occurs near Empire Landing, in Potts Valley on Santa Catalina Island. Owned by the Santa Catalina Island Company, William Wrigley, Jr., president.

The rock is fibrous in structure but takes a fine polish. There are two varieties, hard and soft. The soft variety may be sawed into slabs of any length. The hard variety can be worked with the ordinary stone-cutter's tools. This stone has been used in several buildings in Los Angeles for ornamental, sanitary and electrical purposes, also for lining fireplaces. The quarry has not been worked since 1913.

Bibl: State Mineralogist's Reports X, p. 280; XII, p. 402; XIII, p. 639; Bull. 38, p. 147.



Quarry and grinding plant, Nickel Greenstone Deposit,
Six miles east of Harold, California.

SCHIST AND GREENSTONE.

A belt of gray, micaceous schist crosses Bouquet and San Francisco canyons, having a general strike of N. 20° E. This material is being quarried for use as flagstones. In the low hills east of Harold, a station on the Southern Pacific Railroad, a greenstone is being quarried for use in slate roofing.

Deposits.

Bouquet Canyon Quarry. It is located in Bouquet Canyon, 11 miles northeast of Saugus. Under lease from U. S. Forest Service to Fry and Jacobs, of Sherman, California. Elevation 1950 feet.

A gray, micaceous schist is being quarried for use of driveway sets and stepping stones. The schists split easily in large, flat pieces, which are made up in sets as follows: 2" to 6" in thickness for driveways; 3" to 4" in thickness for stepping stones; 2" to 3" in thickness for grass sets. The material is hauled by truck to Beverly Hills for distribution. Six men are employed.

Jones Quarry. This quarry is located just north of Bouquet Canyon Quarry on the same belt of micaceous schist. Elevation 2000 feet. Under lease to the Natural Rock Products Company. H. H. Jones, of Pasadena, California.

The quarry face is 100 feet in length by 75 feet in height. Material is quarried for use as flagstones. Three men are employed.

San Francisquito Canyon Quarries. These quarries are located in San Francisquito Canyon, near power plant No. 2, 11 miles northeast of Saugus. The rock being quarried is a gray, micaceous schist which can be worked in very thin slabs, but the material is much softer than that in Bouquet Canyon. The following individuals have leases from the U. S. Forest Service in this area: C. J. Ely, of Saugus, California; E. J. Griffith, Pasadena, California; N. H. McCready, Los Angeles, California.

SLATE ROOFING MATERIAL (GREENSTONE).

Breslin Greenstone Quarry. It is located six miles east of Harold, a station on the Southern Pacific Railroad, and one mile west of Little Rock Creek dam. Elevation 3350 feet. Holdings comprise seven claims. Owner, Gene Breslin, of Little Rock.

Several prominent outcrops of green diabase occur in a low range of hills west of Antelope Valley. These outcrops strike east. The material quarried is being shipped to Hidecker Brick Company, of Los Angeles, where it is ground in various sizes for roofing material. Three men are employed.

Nickel Greenstone Quarry. The quarry is located in a low range of hills west of Antelope Valley, in Secs. 21, 28, T. 5 N., R. 11 W., S. B. B. and M., 6 miles east of Harold, a station on the Southern Pacific Railroad. Elevation 3300 feet. Holdings comprise 2 patented claims, 40 acres. Owner, R. E. Nickel, of Acton, California. Under lease to R. C. Sides, of Hollywood, California. There is an exposure of green diabase about 500 feet in width and 1000 feet in length. Four quarry faces have been opened up along the east face of this exposure. The rock is green in color and quite hard. The material quarried is trammed in cars to a crushing and screening plant having a capacity of 25 tons per ten-hour day. A number of products are made as: coarse size, known as No. 1; Dash and No. 2; paper size for green shingles.

The plant is operated under contract by J. F. Stanford, of Little Rock, California. The different products are sacked for shipment to Los Angeles. Three men are employed.

TRACHYTE.

This volcanic rock, consisting chiefly of orthoclase feldspar, occurs on Santa Catalina Island, between Avalon and Empire Landing. Owner, Santa Catalina Island Company, William Wrigley, Jr., president.

The stone is suitable for building purposes, but it has been quarried principally for rubble rock, for use in railroad construction and harbor improvements.

Bibl: State Mineralogist's Reports X, p. 279; XII, p. 404; Bull. 38, p. 155.

CRUSHED STONE, GRAVEL AND SAND.

The extended and ever-increasing use of concrete for buildings, in highways, city streets and pavements makes the matter of crushed stone a matter of great importance. The rapid growth of Los Angeles and the surrounding cities has created a great demand for crushed rock, gravel and sand. The principal source of supply of this material is from the river washes of Arroyo Seco, Pacoima, San Gabriel and Tujunga. Through past ages these streams that have their source in the San Gabriel Range have been depositing boulders and sand over extended areas. These washes, then, as now, were carried by waters down the natural drainage channels toward the ocean, but in spreading out on both sides of the above mentioned streams there was created great deposits of this material in the San Fernando and San Gabriel valleys. The deposits lying within 3 to 5 miles of the base of the mountains have a preponderance of boulders and coarse gravel, with a relatively small percentage of sand; while farther down stream there is apparently more nearly equal proportions of sand and gravel and in which the boulders are smaller. The boulders and gravel of these washes are made up chiefly of granite. The San Gabriel River and the Tujunga River areas constitute producing centers unsurpassed in the mineral aggregate industry of the West. Operations in these areas generally are characterized by steam-shovel work by larger operating plants, while the smaller plants use the dragline method, in the course of which the material is extracted from pits that become wider, longer and deeper as production continues. The presence of coarse gravel and large boulders makes plant operations more of a rock-crushing and dry screening proposition than one of sand and gravel washing and classifying. The entire rock and gravel areas referred to are served by either the Southern Pacific, Santa Fe, or Pacific Electric railroads, affording excellent facilities for shipping plant products into Los Angeles and to all other points in Southern California. The distance from the San Gabriel and Tujunga areas to the center of Los Angeles is from 20 to 25 miles. The products from the different plants are also distributed through dealers by trucks to different parts of the city. For the year 1926, crushed rock registered gains both in tonnage and value over the preceding year; as did also sand and gravel. As for some years past, Los Angeles County led all other counties in the state by a wide margin with an output valued at \$7,472,884.

In the San Gabriel area, the Union Rock Company has seven rock crushing plants under operation. These plants have a capacity of 3000 tons per ten-hour day each, with the exception of the Baldwin Park plant, which has a capacity of 5000 tons. The company is the largest producer of crushed rock, gravel and sand in this area, and with its Brush Canyon plant, located in mountains near Hollywood, capacity 2000 tons, Boulevard and Claremont plants, is said to be the largest producer of crushed rock, gravel and sand under one management in the world. Another large producer of this area is the Reliance Rock Company, with a capacity of 5000 tons.

In the San Fernando area, the largest producing company is the Consumers Rock and Gravel Company. It has 6 plants under operation, with a total capacity of 12,000 tons per ten-hour day. The largest plants are Big Tujunga, near San Fernando, capacity 2500 tons;

Hewitt plant, capacity 2500 tons; Roscoe plant, capacity 3500 tons; and the Sheldon plant, capacity 2500 tons. Another large producer of this area is the Sunset Rock Products Company, with a plant capacity of 2500 tons.

The following rock products companies are operating plants in Los Angeles County:

Alhambra Transfer and Storage Company, Inc., E. Heiger, president. Offices, 1025 Garfield, Alhambra.

Atlas Mixed Mortar Company, J. R. Alder, president; C. T. LaValley, secretary, 2901 Santa Fe Avenue, Los Angeles.

Blue Diamond Materials Company, W. C. Hay, president. Plant at 16th Street and Alameda, Los Angeles.

Builders Crushed Rock Products Company. E. C. Hotchkiss, president, Azusa, California. The plant is located 3 miles west of Azusa, on the San Gabriel wash. The company has under lease 40 acres.

The crushing and screening plant has a capacity of 1200 tons per 12-hour day. At present writing the pit is 1500 feet in length by 100 feet wide and 60 feet deep. The material excavated from the pit carries 70% boulders and coarse gravel with 30% sand. The gravel is loaded by steam shovel into cars, there being two trains of two cars, hauled by two Plymouth gas-driven locomotives. Each of the cars has a capacity of 5 cu. yds. The material from the cars is dumped over railroad-iron grizzly, spaced 6" apart. The minus six-inch material, being sand and gravel, is conveyed by belt conveyor to scalping screen, oversize to secondary crusher, through-size elevated to screening and crushing plant. The oversize from the grizzly goes to large Blake type of crusher and is crushed to pass 5-inch ring. The crushed product is conveyed by belt conveyor to scalping screen; oversize from this screen to secondary crushers; through-size elevated to screening plant. Fifteen men are employed.

Cooperative Building Materials Company. William Bell, president. The plant is located at Roscoe, in San Fernando Valley, one-quarter of a mile east of the Penrose plant of the Consumers Rock and Gravel Company, and 1½ miles south of San Fernando Boulevard. Holdings comprise 20 acres. Capacity of plant is 500 tons per 10-hour day.

The deposit runs 65% rock with 35% sand. The material from pit is delivered to crushing and screening plant by dragline scraper. Seven men are employed.

Concrete Materials Company. The plant is located one-quarter of a mile north of Vineland Avenue, on Sherman Way, Lankershim, in San Fernando Valley. Holdings comprise 10 acres. Concrete Materials Company, H. W. Jones, president; E. M. McAvoy, secretary.

The deposit carries 30% rock with 70% sand. The gravel from pit is delivered by dragline scraper to crushing and screening plant, which has a capacity of 600 tons per 10-hour day. Eight men are employed.

Consumers Rock and Gravel Company. Frank Gautier, president; F. J. Gay, secretary. Main office, 2600 South Alameda Street, Los Angeles.

This company has six plants under operation in San Fernando Valley and is the largest producer of crushed rock products in this area. The combined output of these plants amounts to 12,200 tons per 12-hour day.

Plants.

Big Tujunga Plant. The plant is located at Wahoo Siding, on the Southern Pacific Railroad, on the Big Tujunga wash, east of San Fernando. Holdings comprise 200 acres. Capacity of plant is 2500 tons per 12-hour day. The pit is $1\frac{1}{2}$ miles north of the plant.

The pit run of material carries 65% boulders and coarse gravel and 25% sand and fine gravel. The material is loaded by steam shovels into three trains of Western dump cars, each car having a capacity of 12 tons. These trains are hauled by Plymouth gas-driven locomotives to the crushing and screening plant. The crushed rock products are classified as follows:

No. 1 crushed rock product being $3''$ – $2\frac{1}{2}''$; No. 2, $1\frac{1}{2}''$ to $1''$; No. 3, $1''$ – $\frac{7}{16}''$; No. 4, $\frac{7}{16}''$ to $\frac{3}{16}''$; No. 5, $\frac{3}{16}''$ to dust.

Washed gravel consists of three grades of gravel as: $2\frac{1}{2}''$ to $2''$, $2''$ to $1''$, and $1''$ to $\frac{7}{16}''$ and washed sand.

The capacity of the bunkers amounts to 1200 tons. The bunker stock in excess of that required for current shipments is loaded into cars and there discharged into open storage by one Brown locomotive crane in the yards. The plant requires 900 h.p. to operate it. Water for washing purposes is furnished from a well by a deep-well turbine pump driven by 200-h.p. motor. The bunkers are arranged for both loading of railroad cars and trucks. Thirty men are employed. Mr. Fred Gieroux is superintendent of the plant.

Hewitt Plant. This plant is located at Sherman Way and Pacoima Avenue, Lankershim. Holdings comprise 900 acres. The plant capacity is 2500 tons per 12-hour day.

The present gravel pit is 500 feet wide by 1000 feet in length and 95 feet deep. The material mined from the pit carries 30% coarse gravel, the balance being fine gravel and sand. The material from pit is excavated by Marion electrically-operated shovel and loaded into hopper from which it is transported by 30-inch belt conveyor 500 feet in length to main 30-inch incline conveyor belt 500 feet long to crushing and screening plant. From this main conveyor from pit, the gravel and sand are conveyed by $26''$ belt conveyor to a scalping screen, the sand being screened out. All material over $1\frac{1}{2}''$ size passes to No. 6 McCully gyratory crusher, then passes direct to $36''$ and $48''$ Symonds disc crushers, then to revolving screens, which produce the following crushed rock products: $1\frac{1}{2}''$, $\frac{3}{4}''$, $\frac{1}{4}''$ and dust. The products from washed gravel and sand screening operations are $1\frac{1}{2}''$, $\frac{3}{4}''$ pea gravel, coarse sand and fine sand. The bunker capacity is 6000 tons and the storage over tunnel amounts to 5000 tons.

Water supply is from a well pumped by turbine pump. Plant is operated by electric power. Twenty-eight men are employed. James A. Gautier is superintendent of the plant.

National Plant. This plant is located 3 miles east of Hewitt plant, on Strathem Street, Lankershim. The plant has a capacity of 600 tons per 12-hour day. Holdings comprise 16 acres. Eight men are employed. Mr. Fisher, superintendent.

Penrose Plant. The plant is located one-half mile south of San Fernando Boulevard, on Penrose Avenue, in the city limits of Burbank. It has a capacity of 600 tons per 12-hour day.

The gravel pit is 500 feet in length by 200 feet wide and 90 feet deep. The deposit of gravel contains about 35% coarse gravel. Material from

pit is delivered to screening plant by aerial bucket, having a capacity of 2 yards, which is operated by a hoist. The plant is operated by steam. Eight men are employed. P. J. Gay, superintendent.

Roscoe Plant. The plant is located at Roscoe Siding, on the Southern Pacific Railroad, on the Big Tujunga wash. Holdings comprise 300 acres.

The plant has a capacity of 3500 tons per 12-hour day. It has been operated for a number of years and is the largest producer in the San Fernando Valley district. The gravel pit is one-quarter of a mile in length by 1000 feet wide and 75 feet deep. The gravel from pit contains 50% boulders and coarse gravel.

The material from pit is excavated by 2½ yard Bucyrus shovel and loaded into three trains of three cars, each car having a capacity of 6 yards. It is hauled by 20-ton gasoline driven Plymouth locomotives. The material from cars is dumped directly onto 6" grizzly. The



Roscoe Rock and Gravel Plant, Consumers Rock Company,
Roscoe, San Fernando Valley.

primary crusher is 36" x 42" Buchanan crusher, product goes to scalping screen and then joins feed to two gyratory crushers. The minus 6" rock is conveyed to scalping screen, 48" in diameter by 18' in length, the oversize passing to No. 5 McCully and No. 6 Gates gyratory crushers and is crushed to pass 2½" ring. The product from these crushers is conveyed to two Symonds disc crushers, sizes 45" and 36". The product is ¼" to 1½" sizes, which is conveyed to two revolving screens 48" by 30' in length. Products produced are 1½", ¾", ⅞" to dust. Sand and gravel screened and washed, the products being 1½", ¾", pea gravel and sand.

The total horsepower required to operate plant is 600. Bunker capacity is 1800 tons. The various products from bunkers are loaded in railroad cars or trucks. A 12-ton Plymouth locomotive is used in the yard for hauling railroad cars for loading. A Brown-Bevis crane hoist is used for storing material in yards in stock piles. Thirty-four men are employed. F. G. Gay, plant superintendent.

Sheldon Plant. This plant is located on the Big Tujunga wash, $3\frac{1}{2}$ miles east of San Fernando Boulevard, near Sheldon Avenue and Mulholland Street, Burbank.

The plant is the most modern plant operated by the Consumers Rock and Gravel Company. It has a capacity of 2500 tons per 12-hour day. Holdings comprise 300 acres. At present writing the pit is 2000 feet in length by 300 feet wide and 50 feet deep. The pit run of material carries 75% boulders and coarse sand.

A Bucyrus steam shovel, equipped with $4\frac{1}{2}$ -yard dipper, loads material into three-car trains of Western dump cars, each having a capacity of 6 yards. These trains are hauled to the plant by Plymouth gasoline-driven locomotives. The material from dump cars goes over 5" grizzly, oversize to 42" Kennedy jaw crusher. The minus 5-inch material and crushed rock to 24" belt conveyors, to revolving screen 60" in diameter by 12' long, which takes out 3" size; through-size elevated to sizing screens; oversize to secondary crusher; and plus 3" and minus 6" to Symonds cone crusher, where it is reduced to $1\frac{1}{2}$ " size. Oversize plus 6" goes to gyratory crusher, then through crushed rock circuit to screens. Product from Symonds cone crusher goes to sizing screen (60" diameter by 20' revolving screen), the resulting products being No. 4, $\frac{1}{4}$ " to $\frac{3}{8}$ " round; No. 3, $\frac{3}{8}$ " square to $1\frac{1}{8}$ " round; No. 2, $1\frac{1}{8}$ " round to 2" round; oversize, 2" to $2\frac{3}{4}$ "; No. 1, $2\frac{3}{4}$ to 4" round. The washed sand and gravel from sizing screen produces the following products: Pea gravel $\frac{1}{4}$ to $\frac{3}{8}$ "; $\frac{3}{8}$ " to $1\frac{1}{2}$ "; $1\frac{1}{2}$ " to $2\frac{1}{2}$ ", sand to drag classifier.

The bunker capacity is 1000 tons and ground storage over tunnel has a capacity of 6000 tons. Excess material from bunkers is elevated by 24" conveyor to automatic tripper that distributes the various products to compartments over tunnel. Total horsepower required to operate plant is 600. Water supply from well is pumped by turbine pump, capacity 500 gallons per minute. Broad gauge spur track from main line runs to bunkers. Material also is loaded into trucks from bunkers. Thirty men are employed. Mr. O. J. Langdendorf, superintendent.

Gordon-Garrison-Russell, Inc., H. J. Kingsland, president; Thos. Gordon, secretary, 155 East Jefferson Street, Los Angeles. This company has a plant under operation in Verdugo Canyon, northeast of Montrose. The capacity of the plant is about 600 tons per 10-hour day. Ten men are employed. The company is a large distributor of rock products in Los Angeles, in the capacity of dealers.

Graham Bros., Inc., R. Graham, president; P. Graham, secretary. Offices, 1512 West Seventh Street, Los Angeles.

The Graham Bros. have large bunkers at Long Beach, which are supplied with crushed rock products from Santa Catalina Island Company's quarry located at Pebble Beach, Santa Catalina Island.

The crushed rock from the quarry is loaded on barges by a belt conveyor system and then transported across the channel by tugs to the bunkers at Long Beach. The capacity of the Santa Catalina Island Company's quarry is 1000 tons per 12-hour day.

Graham Bros., Inc., also operate a sand plant on the east slope of the San Pedro Hills, near Lomita. Twelve men are employed.

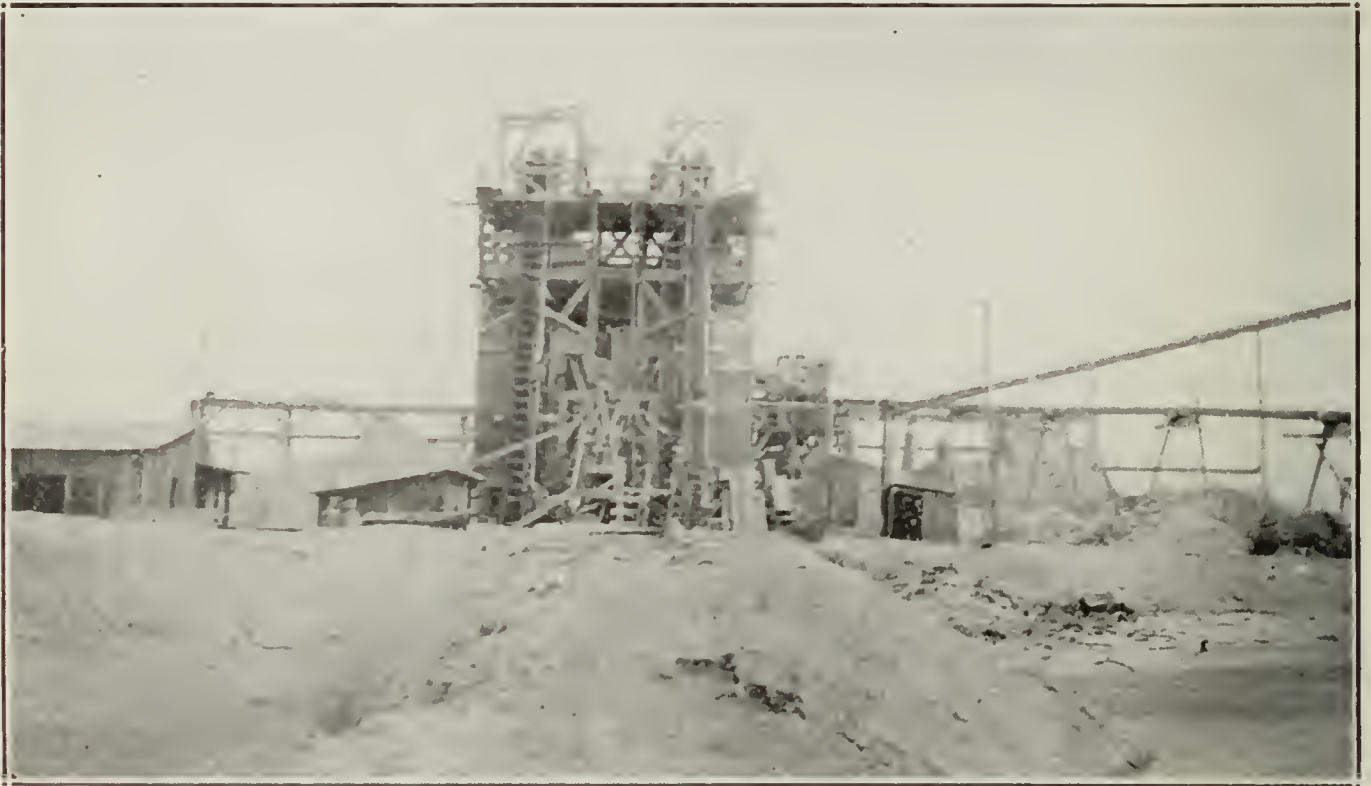
Haines Canyon Rock Company, Peter Perry, president; E. A. Quinn, secretary. Offices, 5200 North San Fernando Road, Glendale, Cali-

fornia. This company has a crushing and screening plant in Haines Canyon, near Sunland.

Livingston Rock and Gravel Company, W. H. Livingston, president. Offices, 19 East Valley Boulevard, Alhambra, California. The crushing and screening plant is located in South Monrovia, on the Rio Hondo wash. The capacity of the plant is about 1000 tons per 12-hour day.

Material Dealers Distributing Company, H. W. Jones, president, San Fernando, California. The plant is located on the Pacoima wash, one mile east of San Fernando. The capacity of the plant is 500 tons per 12-hour day. Ten men are employed.

Pacific Rock Company, Frank W. Aitkin, president, San Fernando, California. The company has 83 acres under lease on the Pacoima wash, two miles southeast of San Fernando. The material from gravel pit is loaded into Western dump cars, which have a capacity of five yards, by Northwestern steam shovel. A train of two cars is hauled by



Pacific Rock Company's Plant, San Fernando, California.

Plymouth gas driven locomotive to the crushing and screening plant. The capacity of the plant is 1200 tons per 12-hour day. Ten men are employed. E. H. Wolfe is plant superintendent.

Pierson and Son operate a small plant located on the Rio Hondo wash, in South Monrovia, one-half mile west of Livingston Rock Company's plant.

Preston Rock Company, G. W. Preston, president, Box 165, Lamanda Park, California. This company operates a crushing and screening plant located in Eaton Canyon, near Pasadena, California.

Rancho Rock Company, David E. Fulwider, president, C. S. Newberry, secretary, 917 Guaranty Building, Los Angeles. The plant is located on the Tujunga wash, west of Roscoe, in the San Fernando Valley. Holdings comprise 25 acres. The plant has a capacity of 600 tons per 12-hour day. The material is delivered from the pit to crushing and screening plant by dragline bucket. Eight men are employed.

Reliance Rock Company. This company is a subsidiary of the Coast Rock and Gravel Company, of San Francisco, California, C. B. Rogers, general manager; R. B. Vaughn, plant superintendent. Offices, 2100 East 25th Street, Los Angeles. Holdings of the company comprise 300 acres located on the east side of the San Gabriel River, two miles west of Azusa, California.

The plant has a capacity of 6000 tons per 12-hour day. The pit run of material carries 75% boulders and coarse gravel and 25% sand and fine gravel. The gravel pit is several thousand feet in length, 300 feet wide and over 100 feet deep. The material from the pit is loaded by two Bucyrus 80-B, steam shovels into a hopper over inclined surface tramway, from hopper, material is fed by Gale-controlled chute into 30-yard tram car. This car is hoisted to crushing plant over incline from pit by 200-h.p. electric-driven hoist. The car is automatically dumped at top of incline into crushing plant hopper, the material going to 6" grizzly. The oversize from grizzly goes to Allis-Chalmers gyra-



Rock and gravel plant, Sunset Rock Products Company, San Fernando Valley.

tory crusher where it is reduced to pass 4" ring. The product from primary crusher goes to two secondary gyratory crushers, and is reduced to 3" size. The product from secondary crusher is fed to a revolving screen having $3\frac{1}{2}$ " openings and short outer jacket of a $1\frac{1}{4}$ " screen. The through-size from this screen is conveyed to open storage as No. 1 crushed rock product. The oversize from this revolving screen is returned to two 10" Allis-Chalmers gyratory crushers and reduced to $1\frac{1}{2}$ " product which is carried to sizing plant by a belt conveyor. The sand and gravel that pass through 6" grizzly is fed to two sets of crushers from which it goes to revolving sand and gravel screen, of $2\frac{1}{2}$ " and $3\frac{1}{2}$ " apertures. The two undersize screen products and recrushed oversize are conveyed by a belt conveyor to main mill. All crushed rock, except No. 1 product, is conveyed by belt conveyor to screening plant, where it is graded by Hummer screens and the mixed sand and gravel are conveyed over a parallel belt conveyor to sand and gravel section of the plant, where it is graded to the various sizes

by rotary screens of the Gilbert type. Crushed rock products are No. 2, $1\frac{1}{2}''$ to $1''$; No. 3, $1''$ to $\frac{7}{16}''$; No. 4, $\frac{7}{16}''$ to $\frac{3}{16}''$; No. 5, $\frac{3}{16}''$ to dust.

Washed gravel products are: $2\frac{1}{2}''$ to $2''$; $2''$ to $1''$; $1''$ to $\frac{7}{16}''$ and washed sand, comprising concrete and asphalt sand. The different grades of crushed rock, gravel and sand go to bunker compartments, from different compartments the desired material falls into a car-loading conveyor, below the bunkers. From this conveyor the material is discharged on a cross conveyor into railroad cars. Bunker stock in excess of that required for current shipments is loaded into railroad cars and then discharged to open storage by two Brown locomotive cranes in the yards. The ground storage amounts to about 750,000 tons. Water for gravel and sand washing is pumped from a well 150 feet deep by a deep-well turbine pump.

Edward Sidebothan and Son, operate two sand plants located in Fossil Bed Canyon, on the east slope of the San Pedro Hills, $1\frac{1}{2}$ miles southwest of Lomita. Office, Pennsylvania Street, Lomita, California.

Sunset Rock Products Company. R. W. Clark, manager, 6372 Hollywood Boulevard, Hollywood, California. The plant is located on Tujunga wash, 2 miles north of San Fernando Boulevard and one mile east of Osborne Avenue, Burbank, California. The plant has a capacity of 2500 tons per 10-hour day.

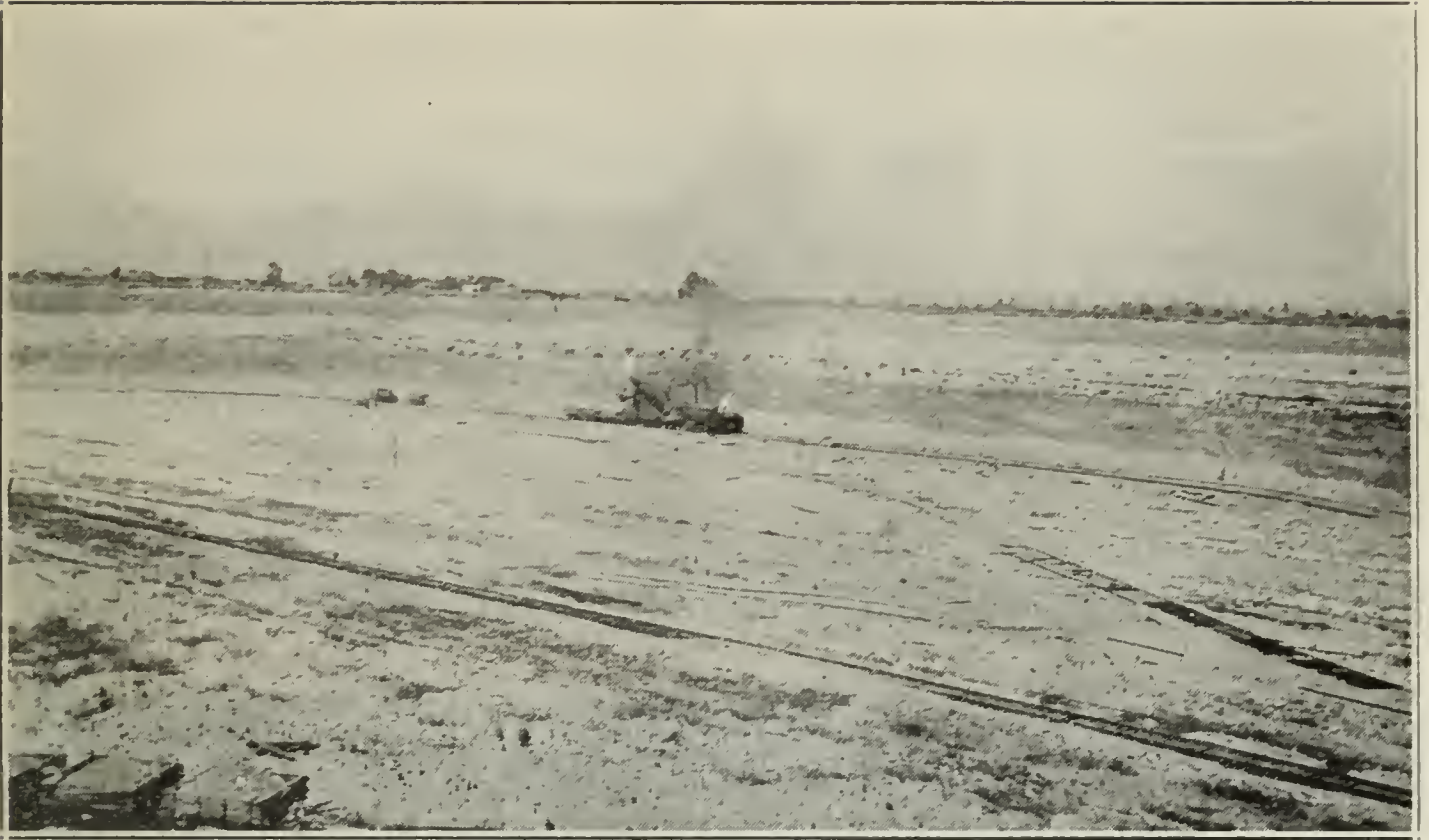
The gravel from the pit is delivered to the crushing and screening plant by dragline bucket. The company owns its own trucks and distributes its products to Los Angeles and the surrounding towns and cities. Twenty-five men are employed in operation of pit and plant. Mr. Brown, plant superintendent.

Stine and Ellis, Rock Products Company, W. L. Stine president; J. R. Ellis, secretary, Burbank, California. The plant is located at Vineland and Victory Boulevard, Lankershim. Holdings comprise 20 acres. The capacity of the plant is 750 tons per 10-hour day.

The material from pit is delivered by dragline two-yard bucket to crushing and receiving plant. The dragline is operated by 100-h.p. electric-driven hoist. Bunker capacity is 300 tons. Three men are employed.

Union Rock Company, George A. Rogers, president; R. E. Rogers, secretary; T. C. Rogers, manager of plants and production; H. O. Chenoworth, general superintendent. This company owns 644 acres with 949 acres under lease and controls 2000 acres additional for rock excavation.

The company produces and distributes more crushed rock, sand and gravel than any other company in Los Angeles County. Eight plants are under operation in the county and six of these plants are located in the San Gabriel Valley and are the Rivas, Kincaid, Largo and Baldwin Park plants. The company has recently acquired the Los Angeles Rock and Gravel Company's plant at Durbin and the American Rock and Gravel Company's plant at Claremont, near the San Bernardino County boundary line. These plants have a capacity of 3000 tons per 10-hour day each, with the exception of the Baldwin Park plant which has a capacity of 5000 tons. The company also operates the Boulevard plant, located on the Tujunga wash in San Fernando Valley, with a capacity of 2500 tons. The Brush Canyon



Gravel pit of Baldwin Park Plant, of Union Rock Company.



Baldwin Park Plant, Union Rock Company.

plant and quarry is located on the west slope of the Hollywood Mountains, 2 miles east of Hollywood. This plant has a capacity of 2000 tons per 10-hour day. For distribution of the rock products, the company has established 13 bunkers in Los Angeles district, each of which has a capacity of about 3000 tons of material, with a combined storage of 34,000 tons. The equipment operated by the company consists of 11 steam locomotives, 4 locomotive cranes, 7 steam shovels, and over 100 trucks for the delivery of rock products. During the year 1924, the production of the company was 3,500,000 tons, which will be materially increased this year by the acquisition of other plants mentioned.

Plants.

Brush Canyon Plant. This plant is located on the eastern slope of Brush Canyon, 2 miles east of Hollywood.

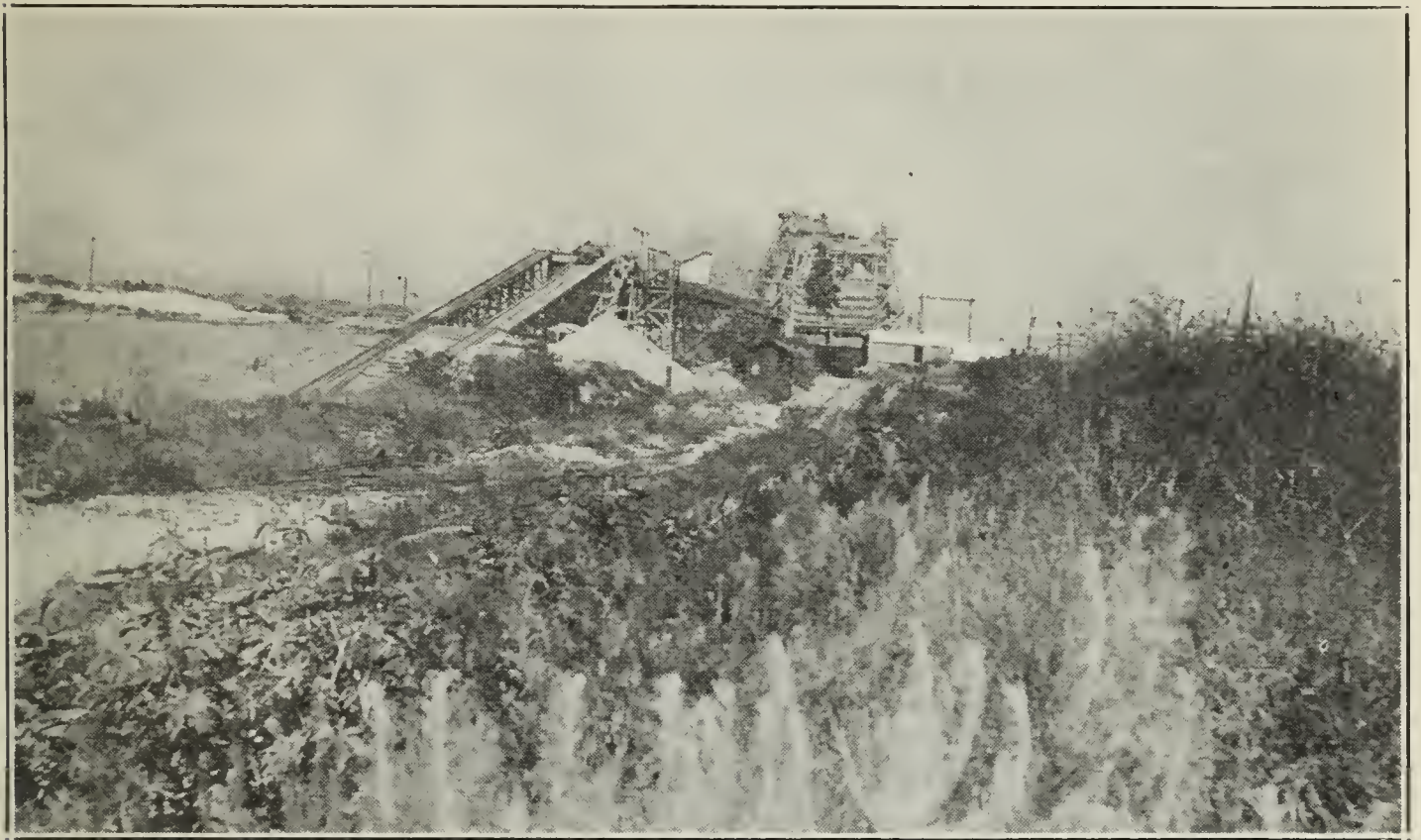


Brush Canyon Quarry, Union Rock Company.

The stone being quarried is a fine-grained crystalline rock, which is about 100 feet in width. It strikes north and dips 50° west. The quarry is 200 feet wide by 700 feet in length and 150 feet in height. The broken rock is loaded in cars by 30-B Bucyrus shovel, then hauled by electric locomotive to crushing plant. The material from cars goes into chute to No. 8 Allis-Chalmers gyratory crusher, where it is crushed to pass $3\frac{1}{2}$ " ring. Product from crusher goes to revolving screen where No. 1 product is taken out, oversize to 48" Symonds disc crusher. The product from the Symonds goes to sizing screens. Ten men are employed at quarry and 6 men in the plant. C. F. Fredley is plant superintendent.

Baldwin Park Plant. This plant is the most modern and complete plant operated by the Union Rock Company. The plant is located one mile northeast of Baldwin Park. It has a capacity of 5000 tons per 10-hour day.

The material treated from the pit contains 60% boulders and coarse gravel with 40% fine gravel and sand. The pit is about one-quarter of a mile wide by one-half mile in length and 65 feet deep. Two steam shovels are operated on different benches in the pit. Three Porter 20-ton locomotives deliver the trains of gravel to incline tramway. The cars are hoisted by electric-driven hoist to top of incline where they are dumped over 4" grizzly, oversize going to Gates gyratory crusher. Then the crushed rock and gravel passes to bin, from which it is loaded into two 4-yard skips, which are hoisted to the top of steel and concrete screening and sizing plant which has a height of 126 feet. Allis-Chalmers 200-h.p. electric-driven hoist operates the skips. Secondary crushers consist of two Allis-Chalmers 10" gyratory crushers and one Symonds 48" disc crusher. The different products go from screens to various compartments in the concrete bunkers. Material from bunkers is loaded into railroad cars. Excess material is unloaded from cars to



Kincaid Rock and Gravel Plant, Union Rock Company.

ground storage by Brown locomotive crane. Twenty-eight men are employed.

Durbin Plant. This plant has recently been acquired by the Union Rock Company. It was formerly operated by Los Angeles Rock Company and is located at Durbin, on the Pacific Electric Railway, 2 miles west of Baldwin Park. The capacity of the plant is about 3000 tons per ten-hour day. Twenty-five men are employed.

Kincaid Plant. This plant is located 2 miles west of Azusa on the San Gabriel wash.

The pit is one-half mile long by 1000 feet in width and 80 feet deep. The gravel from pit contains 75% boulders and coarse gravel, with 25% fine gravel and sand. The material is loaded into cars by Bucyrus steam shovel, which is delivered by locomotive to foot of incline tramway. The cars are hoisted over incline by electric-driven hoist to trestle above the plant. Material from cars goes over 8" railroad iron grizzly, oversize from grizzly to No. 12 Allis-Chalmers gyratory crusher. The

product from this crusher is conveyed to No. 10 gyratory crusher. Sand and gravel and also crushed rock are elevated to screening and washing plant where the various products are classified and to the different compartments in the bunkers. Twenty men are employed.

Largo Plant. It is located on the San Gabriel wash, one mile west of Azusa. Capacity of the plant is 3000 tons per ten-hour day.

The gravel pit is 3000 feet in length by 1000 feet wide and 75 feet in depth. The material carries 75% boulders and coarse gravel and 25% fine gravel and sand. A 60-B Bucyrus shovel with a 2-yard bucket, loads the material into train of ten Western dump cars, each of which has a capacity of 5 yards. A 20-ton Porter locomotive delivers the train to incline tramway over which the cars are hoisted by 200-h.p. electric-driven hoist to platform at head of crushing plant. Two cars are hoisted and the material is dumped onto a railroad iron grizzly, spaced 6 inches apart, the oversize going to No. 12 Gates gyratory crusher. The crushed rock product and the minus 6" sand and gravel are elevated to two revolving screens, one for crushed rock, the other for sand and gravel. Oversize from these screens is returned to No. 6 McCully gyratory crusher. The minus 6" to 3" material from scalping screens goes to 36" and 48" Symonds disc crushers. The product is elevated to Gilbert system of screens where the desired products of crushed rock and gravel are segregated.

This is the oldest and the central plant of the Union Rock Company in the San Gabriel Valley. The company maintains a blacksmith shop and machine shop for repairs on the different plants in the valley. At this plant the bunker capacity is 1000 tons, with ground storage for 200,000 tons of crushed rock products. Excess material from Kincaid plant is stored here. A locomotive is used for moving railroad cars and two Brown locomotive cranes are used for transferring material from cars to stock piles. Twenty-five men are employed. S. L. Yount is plant superintendent.

Rivas Plant. The plant is located on the west side of the San Gabriel River, 3 miles west of Azusa. This is the only gravity plant in this area. It has a capacity of 3000 tons per ten-hour day. The gravel pit is one-quarter of a mile in length by 500 feet wide and 70 feet deep.

The material is made up of 75% boulders and coarse gravel, with 25% fine gravel and sand. The material is excavated by Bucyrus shovel and loaded into train of Western dump cars, each of which has a capacity of 5 yards. A Porter locomotive transports cars to incline tramway. A 300-h.p. direct-connected, electrically driven hoist hauls up train of two cars to trestle over railroad iron grizzly, spaced 6" apart. The material is dumped on grizzly, oversize going to No. 12 Allis-Chalmers gyratory crusher. The crushed rock from this crusher joins the minus 6" material of sand and gravel and falls by gravity into cement storage bin.

The material from bin is loaded into two side-dump cars, each of which has a capacity of 5 yards. These cars are hoisted over incline 1200 feet in length to top of plant by 150-h.p. electrically driven hoist. The material is dumped into hopper at top of plant, from which it goes to scalping screen. The oversize from this screen goes to No. 5 Gates gyratory crusher, where it is crushed to pass 4" ring. This

product goes to 48" Symonds disc crusher. The crushed rock goes to revolving screen which produces the following products: No. 1, 4"; No. 2, $2\frac{1}{2}$ "; No. 3, $1\frac{3}{4}$ "; No. 4, $1\frac{1}{4}$ "; No. 5, $\frac{3}{16}$ " and dust. Gravel and sand from scalping screens go to revolving screen which produces three grades of gravel $2\frac{1}{2}$ " to 2"; 2" to 1", pea gravel and sand. The revolving screens for crushed rock and gravel are installed as parallel units. Oversize gravel and crushed rock from these screens go to 36" Symonds disc crusher. The product from this is elevated to crushed rock screen and goes through the circuit. One thousand horse power is required to operate the plant. Water for gravel and sand washing is pumped from a 500' well by a deep-well turbine pump. The bunker capacity is about 800 tons. Thirty men are employed.



OIL FIELD DEVELOPMENT OPERATIONS.

By R. D. BUSH, State Oil and Gas Supervisor.

From April 3, 1927, to and including July 2, 1927, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
Standard Oil Co.	1	20	15	238	Coalinga
Potter & Esplin.	6	16	14	1	-----
KERN COUNTY:					
California-Kentucky Oil Co.	8	29	21	1	Belridge
Carneros Oil Co.	30	28	21	43	Belridge
Carneros Oil Co.	30	28	21	45	Belridge
Standard Oil Co.	27	28	20	Bacon 1	Belridge
Standard Oil Co.	31	30	25	Kern Co.	
				Lease 1	26 Elk Hills
C. C. M. O. Co.	23	28	27	4	Kern River
C. C. M. O. Co.	23	28	27	5	Kern River
C. C. M. O. Co.	23	28	27	6	Kern River
General Petroleum Corp.	14	28	27	1	Kern River
General Petroleum Corp.	14	28	27	27	Kern River
General Petroleum Corp.	26	28	27	Sill 1	Kern River
General Petroleum Corp.	13	28	27	Young 51	Kern River
George F. Getty	14	28	27	Lehnhardt 9	Kern River
George F. Getty	14	28	27	Lehnhardt 10	Kern River
George F. Getty	14	28	27	Lehnhardt 11	Kern River
George F. Getty	14	28	27	Lehnhardt 12	Kern River
George F. Getty	14	28	27	Lehnhardt 20	Kern River
George F. Getty	14	28	27	Lehnhardt 21	Kern River
George F. Getty	14	28	27	Lehnhardt 22	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 17	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 18	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 19	Kern River
George F. Getty, Inc.	22	28	27	Tegeler 22	Kern River
Standard Oil Co.	15	28	27	5	Kern River
Standard Oil Co.	15	28	27	6	Kern River
Standard Oil Co.	15	28	27	7	Kern River
Standard Oil Co.	27	28	27	7	Kern River
Standard Oil Co.	15	28	27	8	Kern River
Standard Oil Co.	27	28	27	8	Kern River
Standard Oil Co.	15	28	27	9	Kern River
Standard Oil Co.	27	28	27	9	Kern River
Standard Oil Co.	15	28	27	10	Kern River
Standard Oil Co.	11	28	27	Universal 1	Kern River
Tarr & McComb, Inc.	2	29	28	11	Kern River
Tarr & McComb, Inc.	2	29	28	12	Kern River
F. G. Wagner	34	28	28	2	Kern River
F. G. Wagner	34	28	28	4	Kern River
Wonder Co., Ltd.	23	28	27	2	Kern River
Wonder Co., Ltd.	23	28	27	14	Kern River
Ozena Oil Co.	27	29	21	1	McKittrick
C. C. M. O. Co.	22	31	22	37	Midway
Electric Petroleum Corp.	34	30	22	1	Midway
Midway Peerless Oil Co.	15	31	22	3-X	Midway
North American Oil Cons.	32	31	24	10	Midway
North American Oil Cons.	32	31	24	11	Midway
Standard Oil Co.	27	31	23	4	Midway
Standard Oil Co.	31	31	24	28	Midway
Standard Oil Co.	31	31	24	29	Midway
Standard Oil Co.	7	32	24	59	Midway
Standard Oil Co.	17	32	24	70	Midway
Standard Oil Co.	7	32	24	232	Midway
The United Oil Co.	6	31	23	Mason 5	Midway
Poso Pete Co.	32	26	28	Kathryn	
				Hyde 1	Mt. Poso
Shell Co.	9	27	28	Vedder-Rall 3	Mt. Poso
Pacific American Oil Co.	10	11	23	Akridge 1	Sunset
Raleigh Oil Co.	8	11	23	1	Sunset

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued.					
Standard Oil Co.....	31	12	23	32	Sunset
Standard Oil Co.....	5	11	23	140	Sunset
M. H. Whittier Co.....	1	11	24	9	Sunset
Bomke and Ball.....	12	29	20	Larson 1	Temblor
R. B. Jackson and J. F. Harrison....	36	29	20	1	Temblor
Max L. Pray.....	1	29	20	2	Temblor
Elbe Oil Land Development Co.....	18	28	29	2	-----
Elbe Oil Land Development Co.....	18	28	29	3	-----
Elbe Oil Land Development Co.....	18	28	29	4	-----
Elbe Oil Land Development Co.....	18	28	29	5	-----
Elbe Oil Land Development Co.....	20	28	29	6	-----
H. L. Whiston.....	20	27	29	1	-----
KINGS COUNTY:					
General Petroleum Corp.....	26	22	18	Ochsner 2	-----
William Gilbert.....	20	23	19	Barritt 1	-----
William Gilbert.....	4	23	19	Barritt 2	-----
William Gilbert.....	28	23	19	Ogden Akst 1	-----
LOS ANGELES COUNTY:					
Alanson Co.....	18	2	14	Phil Young, Jr. 2	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 43	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 44	Inglewood
Standard Oil Co.....	17	2	14	L.A. Invest. 1 53	Inglewood
Standard Oil Co.....	16	2	14	Baldwin-	
				Cienega 62	Inglewood
Standard Oil Co.....	16	2	14	Stocker 11	Inglewood
California Petroleum Corp.....	19	4	12	Davidson 6	Long Beach
Campbell Co.....	29	4	12	1	Long Beach
Davis & Macmillan Co.....	19	4	12	14	Long Beach
Delaney Petroleum Corp.....	29	4	12	7	Long Beach
Italo American Petroleum Corp.-					
Modoc Petroleum Corp.....	19	4	12	Italo 4	Long Beach
Shell Co.....	19	4	12	Cresson	
				Comm. 8	Long Beach
Shell Co.....	19	4	12	Cresson	
				Comm. 9	Long Beach
Shell Co.....	19	4	12	Cresson	
				Comm. 10	Long Beach
Shell Co.....	19	4	12	Cresson	
				Comm. 11	Long Beach
Signal Syndicate No. 3.....	19	4	12	4	Long Beach
Travis Drilling Co.....	29	4	12	Travis 1	Long Beach
Charles S. Florsheim.....	1	2	12	1	Montebello
Standard Oil Co.....	2	2	12	Stocker-	
				Merced 1	Montebello
Union Oil Co.....	31	2	11	Howard 8	Santa Fe Springs
T. H. M. Aitken.....	3	5	12	Aitken 1	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 9	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 10	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 11	Seal Beach
Associated Oil Co.....	11	5	12	Bryant 22	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 4	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 16	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 17	Seal Beach
Fred A. Ballin and Fred Erwing....	3	5	12	2	Seal Beach
Bankline Oil Co.....	3	5	12	Park 1	Seal Beach
H. J. Barneson.....	3	5	12	Brust & Shore 1	Seal Beach
H. J. Barneson.....	3	5	12	Fueller 1	Seal Beach
California American Oil Co.....	3	5	12	1	Seal Beach
California Eastern Oil Co.....	3	5	12	Fleming 1	Seal Beach
California-Eastern Oil Co.	3	5	12	Hodges-Wilson 1	Seal Beach
California Eastern Oil Co.....	3	5	12	Judson 2	Seal Beach
California Eastern Oil Co.....	3	5	12	Judson 3	Seal Beach
California Eastern Oil Co.....	3	5	12	Judson 4	Seal Beach
California Eastern Oil Co.....	3	5	12	Judson 5	Seal Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Cont.					
California Eastern Oil Co.-----	3	5	12	Judson 6	Seal Beach
California Eastern Oil Co.-----	3	5	12	Judson 7	Seal Beach
California Eastern Oil Co.-----	3	5	12	Judson 8	Seal Beach
California Eastern Oil Co.-----	3	5	12	Judson 9	Seal Beach
California Eastern Oil Co.-----	3	5	12	Layden-	
				Lampdon 1	Seal Beach
California Eastern Oil Co.-----	3	5	12	Parr 1	Seal Beach
California Eastern Oil Co.-----	3	5	12	Raymond &	
				Larsen 1	Seal Beach
Coastal Oil Co.-----	3	5	12	3	Seal Beach
E. L. Cragen-----	3	5	12	1	Seal Beach
Dill & Comstock-----	3	5	12	1	Seal Beach
Dill & Comstock-----	3	5	12	2	Seal Beach
Fred Erwing-----	3	5	12	1	Seal Beach
Failing & Wallace-----	3	5	12	1	Seal Beach
Fleet Petroleum Corp.-----	3	5	12	11	Seal Beach
General Petroleum Corp.-----	3	5	12	Counts 1	Seal Beach
General Petroleum Corp.-----	3	5	12	Hemphill 1	Seal Beach
General Petroleum Corp.-----	4	5	12	W. & W. 1	Seal Beach
General Petroleum Corp.-----	3	5	12	Wascm 10	Seal Beach
George F. Getty, Inc.-----	3	5	12	S. B. 10	Seal Beach
George F. Getty, Inc.-----	3	5	12	S. B. 11	Seal Beach
George F. Getty, Inc.-----	3	5	12	S. B. 12	Seal Beach
George F. Getty, Inc.-----	3	5	12	S. B. 13	Seal Beach
George F. Getty, Inc.-----	3	5	12	S. B. 14	Seal Beach
Edward B. Giffen-----	3	5	12	Alamitos 1	Seal Beach
Reuben R. Horwitz-----	3	5	12	1	Seal Beach
Italo American Petroleum Corp.-----	3	5	12	Italo 20	Seal Beach
Loftin Oil Co.-----	4	5	12	Loftin 1	Seal Beach
Loftin Oil Co.-----	3	5	12	Outpost 1	Seal Beach
C. B. Lones-----	3	5	12	Jones 1	Seal Beach
Marland Oil Co.-----	10	5	12	McGrath &	
				Selover 6	Seal Beach
McAlpine Petroleum Co.-----	3	5	12	McAlpine	
				Alamitos 1	Seal Beach
M. W. McVey-----	3	5	12	Alamitos 1	Seal Beach
M. W. McVey-----	3	5	12	Alamitos 2	Seal Beach
Leland Mitchell-----	3	5	12	1	Seal Beach
John H. Peacock, Trustee-----	3	5	12	1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bott 1	Seal Beach
Petroleum Securities Co.-----	4	5	12	Breig 1	Seal Beach
Petroleum Securities Co.-----	3	5	13	Brice 1	Seal Beach
Petroleum Securities Co.-----	35	5	12	Brisendine 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 2	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 3	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 4	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 5-A	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 6-A	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 7-A	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 1-B	Seal Beach
Petroleum Securities Co.-----	3	5	12	Bryant 2-B	Seal Beach
Petroleum Securities Co.-----	3	5	12	Dexter 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Dotson 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Evans Fee 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Gieck 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Heller 1	Seal Beach
Petroleum Securities Co.-----	4	5	12	Horwitz 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	James 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Kellas 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Kindig 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Lieberman 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Marquis 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Murphy 1	Seal Beach
Petroleum Securities Co.-----	3	5	12	Murphy 2	Seal Beach
Petroleum Securities Co.-----	3	5	12	Naples 6	Seal Beach
Petroleum Securities Co.-----	3	5	12	Naples 7	Seal Beach
Petroleum Securities Co.-----	3	5	12	Nicholson 1	Seal Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

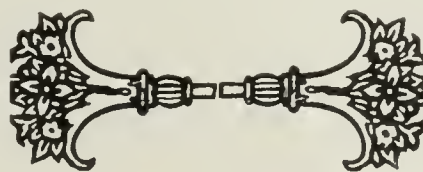
Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Cont.					
Petroleum Securities Co.....	3	5	12	Parr-Person 1	Seal Beach
Petroleum Securities Co.....	3	5	12	Parr-Person 2	Seal Beach
Petroleum Securities Co.....	3	5	12	Parr-Person 3	Seal Beach
Petroleum Securities Co.....	3	5	12	Parr-Person 4	Seal Beach
Petroleum Securities Co.....	3	5	12	Thurston 1	Seal Beach
Petroleum Securities Co.....	3	5	12	Wahl 1	Seal Beach
Petroleum Securities Co.....	3	5	12	Williams 1	Seal Beach
Petroleum Securities Co.....	3	5	12	Williams 2	Seal Beach
W. M. Richmond.....	3	5	12	Richmond-Summy 1	Seal Beach
Ring Petroleum Corp.....	3	5	12	10	Seal Beach
Fred W. Roberts.....	3	5	12	Alamitos 1	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 13	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 14	Seal Beach
Union Drilling & Petroleum Co.....	3	5	12	Burge 1	Seal Beach
Union Drilling & Petroleum Co.....	3	5	12	Smeeton 1	Seal Beach
Fred A. Walker.....	4	5	12	Byrne 1	Seal Beach
Warren and Macrate.....	3	5	12	Warren & Macrate 1	Seal Beach
J. G. Wheeler.....	3	5	12	1	Seal Beach
White Eagle Petroleum Co.....	3	5	12	1	Seal Beach
White Eagle Petroleum Co.....	3	5	12	2	Seal Beach
White Eagle Petroleum Co.....	3	5	12	3	Seal Beach
White Eagle Petroleum Co.....	3	5	12	4	Seal Beach
White Eagle Petroleum Co.....	3	5	12	5	Seal Beach
White Smithson Oil Co.....	3	5	12	Alamitos 1	Seal Beach
C. C. M. O. Co.....	17	4	14	Del Amo 71	Torrance
C. C. M. O. Co.....	17	4	14	Del Amo 76	Torrance
C. C. M. O. Co.....	8	4	14	Del Amo 90	Torrance
C. C. M. O. Co.....	10	4	14	Torrance 90	Torrance
J. E. O'Donnell.....	7	4	13	O'Donnell 58	Torrance
Associated Oil Co.....	2	3	14	Johnson 1	-----
George F. Getty, Inc.....	26	2	12	Marland 1	-----
Joseph Hummel.....	11	2	14	1	-----
R. W. and Geo. H. Jackson.....	8	3	14	Jackson-Leuzinger 1	-----
McCoy-Thomason Drilling Co.....	27	5	16	1	-----
Shell Co.....	4	2	15	Mission 1	-----
Southwest Petroleum Co.....	4	3	13	Ramsaur 1	-----
Standard Oil Co.....	36	1	15	Marblehead 1	-----
MERCED COUNTY:					
John E. Faber.....	19	6	11	1	-----
ORANGE COUNTY:					
Brea Canon Oil Co.....	1	3	10	42	Brea Olinda
Chicksan Oil Co.....	19	3	9	Mathis 1	Coyote Hills
General Petroleum Corp.....	19	3	9	Wallop 1	Coyote Hills
Herndon & Hunter.....	19	3	9	Herndon 2	Coyote Hills
Holly Development Co.....	20	3	9	Barnett 1	Coyote Hills
Angelus Petroleum Co.....	10	6	11	Porter 1	Huntington Beach
California Petroleum Corp.....	28	5	11	Buck 4	Huntington Beach
Calnan Petroleum Co.....	36	5	11	1	Huntington Beach
Colonial Oil Co.....	10	6	11	2	Huntington Beach
E. E. Combs.....	10	6	11	8	Huntington Beach
E. L. Cragen.....	10	6	11	1	Huntington Beach
Crudoil Co.....	10	6	11	14	Huntington Beach
Crudoil Co.....	10	6	11	16	Huntington Beach
J. E. Hall.....	10	6	11	2	Huntington Beach
J. E. Hall.....	10	6	11	3	Huntington Beach
J. E. Hall.....	10	6	11	4	Huntington Beach
J. E. Hall.....	10	6	11	5	Huntington Beach
Hart & Collins.....	10	6	11	1	Huntington Beach
C. L. Hussey.....	10	6	11	1	Huntington Beach
James & Price.....	10	6	11	Bolton 1	Huntington Beach
Kohlbusch & Johnston, Inc.....	10	6	11	Wold 1	Huntington Beach
Loftin Oil Co.....	10	6	11	Cain 1	Huntington Beach
Merritt Annex Oil Co.....	27	5	11	Lindner 1	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued.					
John J. Mullin.....	10	6	11	Nevada 3	Huntington Beach
Pacific Coast Oil Co.....	10	6	11	2	Huntington Beach
Petroleum Securities Co.....	13	6	11	Mills 1	Huntington Beach
Fred W. Roberts.....	10	6	11	H. B. 5	Huntington Beach
W. W. Stabler.....	10	6	11	McClure 1	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 8	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 9	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 10	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 11	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 12	Huntington Beach
Standard Oil Co.....	10	6	11	P. E. 13	Huntington Beach
Superior Oil Co.....	10	6	11	Berry 1	Huntington Beach
Superior Oil Co.....	10	6	11	Groves 1	Huntington Beach
Superior Oil Co.....	10	6	11	Ruby Jones 1	Huntington Beach
Texas Holding Co.....	2	6	11	4	Huntington Beach
W. B. Thompson.....	10	6	11	Thompson 2	Huntington Beach
Treat Petroleum Corp.....	10	6	11	1	Huntington Beach
Frances H. Upman.....	11	6	11	Hecla 1	Huntington Beach
Wellington Oil Co.....	2	6	11	3	Huntington Beach
World Petroleum Corp.....	10	6	11	Mathews &	
				Berinan 5	Huntington Beach
World Petroleum Corp.....	10	6	11	Mathews &	
				Berman 6	Huntington Beach
Associated Oil Co.....	33	3	9	Kammerer 6	Richfield
California Petroleum Corp.....	32	3	9	Bradford 6	Richfield
California Petroleum Corp.....	33	3	9	Heartwell 2	Richfield
California Petroleum Corp.....	33	3	9	Krug 9	Richfield
California Petroleum Corp.....	34	3	9	Richfield	
				Cons. 15	Richfield
General Petroleum Corp.....	33	3	9	Pedeco 1	Richfield
General Petroleum Corp.....	33	3	9	Pedeco 2	Richfield
George W. Johnson.....	27	3	9	Swain 1	Richfield
Nugent Drilling Co.....	27	3	9	2	Richfield
Shell Co.....	31	3	9	Peter J. Allee 1	Richfield
Signal Syndicate No. 4.....	33	3	9	6	Richfield
Standard Oil Co.....	34	3	9	Son-Crail-	
				Locke 1	Richfield
Standard Oil Co.....	34	3	9	L. Vejar 1	Richfield
Standard Oil Co.....	34	3	9	L. Vejar 2	Richfield
Standard Oil Co.....	27	3	9	Yorba Linda	
				Water Co. 1	Richfield
Union Oil Co.....	33	3	9	Stern 9	Richfield
Union Oil Co.....	33	3	9	Stern 10	Richfield
Union Oil Co.....	34	3	9	Yorba Linda	
				Group 13	Richfield
O. K. Carr.....	13	8	8	1	
Standard Oil Co.....	17	4	9	Zaiser-Brelje 1	
Tower and Olsen.....	3	6	10	1	
RIVERSIDE COUNTY:					
Hemet Petroleum Corp.....	10	5	1	1	
SAN BENITO COUNTY:					
Homestake Oil Co.....	14	17	11	4	
SAN BERNARDINO COUNTY:					
Lamona Oil Assn.....	21	2	8	Vizio 1	
Summit Oil Co.....	20	3	5	1	
SAN LUIS OBISPO COUNTY:					
San Luis Syndicate.....	--	31	13	1	Arroyo Grande
Trustees Well.....	25	32	14	1	
SANTA BARBARA COUNTY:					
Palmer Union Oil Co.....	30	9	32	Stendel 12-A	Cat Canyon
Palmer Union Oil Co.....	30	9	32	Stendel 13-A	Cat Canyon
Miley Oil Co.....	3	4	29	Goleta 1-A	Goleta
Barnsdall Oil Co.....	36	4	30	Edwards 1	Goleta

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
SANTA BARBARA COUNTY—Cont.					
Berry Oil Co.-----	1	4	29	Cavalletto 1	Goleta
Berry Oil Co.-----	1	4	29	Palmetto 1	Goleta
California Eastern Oil Co.-----	3	4	29	Doty 1	Goleta
Graham-Loftus Oil Co.-----	36	5	31	1	Goleta
Miley Oil Co.-----	3	4	29	Goleta 4	Goleta
Miley Oil Co.-----	3	4	29	Goleta 5	Goleta
Miley Oil Co.-----	4	4	29	Goleta 7	Goleta
Levi Smith-----	3	4	29	2-A	Goleta
Smith & Barmore-----	--	4	26	5	Summerland
Smith & Barmore-----	--	4	26	6	Summerland
Smith & Barmore-----	--	4	26	7	Summerland
Smith & Barmore-----	--	4	26	8	Summerland
Smith & Barmore-----	--	4	26	9	Summerland
Smith & Barmore-----	--	4	26	10	Summerland
SANTA CLARA COUNTY:					
Continental Oil Co.-----	31	11	4	1	Sargent
W. H. Lingenfelter-----	8	9	1	1	-----
SOLANO COUNTY:					
H. Rambke-----	17	7	1	1	-----
H. Rambke-----	22	7	1	1	-----
SONOMA COUNTY:					
Shell Co.-----	14	5	7	Ielmorini 1	-----
TULARE COUNTY:					
A. Otis Birch-----	13	21	26	Baker 1	-----
VENTURA COUNTY:					
Santa Fe Petroleum Co.-----	17	4	18	Fleisher 1	Piru
Wheeler Canon Oil Co.-----	25	4	22	17	Santa Paula
Little Sespe Economic Oil Corp.-----	5	4	19	Dixie 4	Sespe
Oak Ridge Oil Co.-----	18	3	20	Willard 22	South Mountain
Associated Oil Co.-----	22	3	23	Hartman 10	Ventura
Associated Oil Co.-----	27	3	23	Lloyd 51	Ventura
Associated Oil Co.-----	23	3	23	McGonigle 4	Ventura
C. C. M. O. Co.-----	8	3	24	1	Ventura
C. C. M. O. Co.-----	17	3	24	State 1	Ventura
McBride & Rogers-----	21	3	23	Ventura 1	Ventura
Shell Co.-----	28	3	23	Edison 17	Ventura
Shell Co.-----	28	3	23	Edison 18	Ventura



SPECIAL ARTICLES.

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of 'Mining in California.'

These special articles cover a wide range of subjects, both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

The law governing the licensing of dealers in gold-silver ores and bullion which originally became effective July 24, 1925, was revised and amended at the forty-seventh session of the legislature, in 1927. The text of the amended act now in force, commonly known as the High Grade Law, is given herewith:

ORE BUYERS LICENSE ACT,

commonly referred to as

"THE HIGH GRADE LAW."

Chapter 70, Statutes 1925, Amended 1927.

An act to provide for the regulation, control and licensing of any person, firm or corporation, engaged in the business of milling, sampling, concentrating, reducing, refining, purchasing or receiving for sale ores, concentrates, or amalgams, bearing gold or silver, gold dust, silver or gold bullion, nuggets or specimens; to provide rules and regulations therefor; and to provide penalties for the violation of the provisions of this act.

SECTION 1. Hereafter it shall be unlawful for any person, firm, association or corporation without first procuring the license herein provided for, to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing or receiving for sale ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets or specimens. Every person, firm, association, or corporation engaged in such business shall pay a license tax of twenty-five dollars per annum to the State of California. No license shall be granted to any person, firm or association unless such person and the members of such firm or association shall be bona fide residents of the State of California, and no license shall be granted to any joint stock company or corporation organized under the laws of any other state or foreign country unless such company or corporation has complied with all the laws of this state relating to the qualifications of foreign corporations to do business in this state; *provided*, that this section shall not be construed

as requiring a license for any mill, sampler, concentration or reduction plant used exclusively by the owner in sampling, milling, reducing or concentrating ores produced by such owner.

SEC. 2. The application for license to carry on such business must be made to the state mineralogist of the State of California, and shall contain the full names and addresses of applicants, if natural persons, and in the case of firms and associations the full names and addresses of the members thereof, and in the case of corporations, the full names and addresses of the officers and directors thereof, and the place or places where such business is to be carried on. Such application shall be sworn to by the person making it. Every license granted shall date from the first day of the month in which it is issued and expire on the thirty-first day of the following December, and such license or copies thereof shall be kept conspicuously displayed in the place or places of business of the licensee within the State of California. Every application shall be filed not less than thirty days prior to the granting of such license, and notice of the filing of such application shall be posted in the office of said state mineralogist and be published at the cost of the applicant once a week for three successive weeks in a newspaper published in the county or counties where such business is to be carried on. Protest may be made by any person to the issuing of such license, and when such protests are filed with the state mineralogist, the latter shall give notice of and hold a public hearing upon said protest before issuing such license. The said state mineralogist shall have the power to reject any application or license after a hearing upon such protest as aforesaid, and he shall also have power to revoke any license for failure on the part of the licensee to observe this act or any part thereof, or when the licensee shall have violated the provision or provisions of any law of the State of California relating to ore buying or of any law of said state relating to larceny or receiving stolen property; *provided*, that no license shall be revoked except upon written charges filed by two or more reputable persons as accusers, specifying the violations of law for which revocation is sought, and after a public hearing as in case of protests against the granting of licenses. An application for a review of any order granting, refusing, or revoking, a license made by the state mineralogist under this act, may be made to the superior court in and for the county where the aggrieved parties reside, by any person or persons who may feel aggrieved by such order and whose name or names appear in the record of the proceedings before the state mineralogist as a licensee, applicant for license, protestant, or accuser, by lodging in the office of the clerk of said court a certified copy of the transcript of the proceedings before the state mineralogist, including copies of all papers filed therein. The transcript shall be accompanied by a short petition naming the person or persons applying for the review as plaintiff or plaintiffs and the state mineralogist as defendant, and praying for a review of the order.

Within ten days after lodging such application the party or parties applying for the review shall serve notice of its pendency upon the state mineralogist, in writing, and if the review be of an order granting a license or refusing to revoke a license, such notice shall also be served upon the person to whom the license was thereby granted or whose license was thereby permitted to remain in force.

Such notice may be served by personal delivery or by registered mail, and proof of service shall be made to the satisfaction of the court if not admitted. No review shall be allowed unless taken within thirty days after entry of the order. The said court shall try all such reviews upon the transcript, and such evidence as may be offered and admitted. When the court has finally determined any such proceeding, it shall forthwith cause its order in the premises to be certified to the state mineralogist. The costs in such review shall be awarded at the discretion of the court, and if any costs are awarded against the state mineralogist, the same shall be paid out of funds arising from the payment of license fees under this act. When a review is had, as herein provided, of an order of the state mineralogist revoking a license, such review shall operate as a stay upon such order.

For the making of the transcript herein provided for, the state mineralogist shall collect from the person or persons ordering the same, twenty-five cents per folio of one hundred words, and twenty-five cents for certifying the same.

The superior court in and for the county or city and county in which the aggrieved party or parties reside shall have the right and jurisdiction to review the action of the state mineralogist in granting, refusing, or revoking a license.

SEC. 3. Each application shall be accompanied by a bond to be approved by the said state mineralogist to the people of the State of California in the penal sum of three thousand dollars (\$3,000), with two or more sufficient sureties or by a surety company duly authorized to do business in this state, and conditioned that the obligor will not violate any law applicable to such business. If any person shall be aggrieved by the misconduct of any such licensee through his violation of any law relating to such business, and shall recover a judgment therefor, such person may, after a return unsatisfied in whole or in part of any execution issued upon said judgment, maintain an action in his own name upon such bond herein required in any court of competent jurisdiction. The state mineralogist shall furnish to any one applying therefor a certified copy of any such bond filed with him, upon the payment of a fee of twenty-five cents, and such certified copy shall be prima facie evidence in any court that such bond was duly executed and delivered by each person whose name appears thereon. Said bond shall be renewed and refiled prior to the date of its expiration, or the licensee shall, within thirty days thereafter, cease doing business, and his license shall be revoked by said state mineralogist; but said bond until renewed and refiled, shall remain in full force and effect for a period of three years from the time of approval thereof by the state mineralogist.

SEC. 4. Every person, firm, association or corporation, carrying on such business, shall keep and preserve a book in which shall be entered at the time of the delivery of any ores, concentrates or amalgams, bearing gold or silver, gold dust, gold or silver bullion, nuggets or specimens:

First—The name of the party on whose behalf such ores, concentrates, gold dust, gold or silver bullion, nuggets or specimens are delivered;

Second—The weight, or amount, and a short description of each lot thereof;

Third—The name and location of the mine or claim from which it shall be stated that the same has been mined or procured ;

Fourth—The name of the party delivering the same ;

Fifth—The date of delivery ; and

Sixth—Whether the party making the delivery is a lessee, superintendent, foreman, or workman in such mine.

Such book shall be open for inspection to the state mineralogist, his deputies, officers, and agents, on every day except Sundays and legal holidays, between the hours of nine o'clock in the forenoon and five o'clock in the afternoon. If any person, on his own behalf or being duly authorized thereunto by another, shall make and file with the said state mineralogist an affidavit stating that to his best knowledge and belief he or his principals, as the case may be, has, within the three months next preceding the filing of such affidavit, sustained a loss of any of the above described property, by theft or trespass, and that he believes that such property was delivered to a licensee under this act, naming such licensee, the state mineralogist shall forthwith issue a permit to such person to examine the book kept by such licensee under this act ; and upon the presentation of such permit to such licensee, such person shall have the right to inspect and examine the entries made in said book during said period of three months, on the same terms and conditions as the state mineralogist.

SEC. 4a. The state mineralogist shall prescribe the form and contents of all reports in order to comply with section 4 of this act and it shall be the duty of every person, firm, association or corporation to file monthly with the state mineralogist a report of all purchases made under the provisions of this act. Any licensee who shall fail or refuse to comply with the provisions of this act shall be deemed guilty of a misdemeanor.

SEC. 5. Any licensee under this act who shall fail, or neglect or refuse to keep and preserve the book herein provided for, shall forfeit his license and shall in addition, upon conviction, be liable to the penalties provided in section 8 of this act. Any licensee or other person who shall knowingly make any false entries upon such book, or knowingly enter or cause to be entered upon the same any false or fictitious names, shall upon conviction, be liable to the penalties provided in section 8 of this act. Any licensee who shall refuse to permit any person duly authorized as herein provided to inspect said book or the entries therein, shall, on conviction, be liable to the penalties provided for a violation of this act and shall forfeit his license.

SEC. 6. Any person who shall knowingly make any false statements concerning any of the facts required to be stated in section 4 of this act shall be guilty of a misdemeanor.

SEC. 7. Complaints against any licensee or applicant shall be made in writing to said state mineralogist, and reasonable notice thereof, not less than three days, shall be given to said licensee or applicant by serving upon him a copy of such complaint, and a hearing shall be had before the said state mineralogist within one week from the date of the filing of the complaint, and no adjournment shall be taken for longer than one week. A daily calendar shall be kept of all hearings by said state mineralogist, which shall be posted in a conspicuous place in his public office for at least three days before the date of such hearing.

The said state mineralogist shall keep a record of all such complaints and hearings, and may refuse to issue and shall suspend or revoke any license for any good cause shown, within the meaning and purpose of this act; and when it is shown that any licensee or applicant under this act, either before or after conviction, is guilty of any conduct in violation of this or any law relating to such business, it shall be the duty of the said state mineralogist of the State of California to suspend, revoke or reject the license of such licensee or applicant, but notice of the proposed action shall be presented to and reasonable opportunity shall be given licensee or applicant to be heard in his defense. Whenever for any reason such license is revoked, said state mineralogist shall not issue another license to said licensee until the expiration of at least one year from the date of revocation of such license. The state mineralogist shall decide all matters submitted to him within thirty days from the time he takes them under advisement.

SEC. 8. Any violation of sections 1, 4, 4a and 5 of this act shall be punishable by a fine of not less than one hundred dollars and not more than one thousand dollars, or by imprisonment in the county jail for not less than thirty days nor more than six months, or both such fine and imprisonment. The state mineralogist shall notify the district attorney of the county in which the offense occurs of such violation, and the said district attorney shall institute criminal proceedings for the enforcement of this act before any court of competent jurisdiction.

SEC. 9. The expenses of the state mineralogist arising out of this act shall be defrayed out of the moneys paid in from time to time for licenses issued hereunder. Any balance remaining in the hands of said state mineralogist on the thirty-first day of December of each year, derived through this act shall be turned over to the general fund of the state.

SEC. 10. Should the duties of the state mineralogist be transferred to a director or department of mines and mineral resources, all of the powers, rights, duties and responsibilities of the state mineralogist provided in this act shall be thereby transferred to such director or department of mines and mineral resources.

SEC. 11. If any section, sentence, clause or phrase of this act is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this act. The legislature hereby declares that it would have passed this act and each sentence, clause and phrase thereof, irrespective of the fact that any one or more of the sections, sentences, clauses or phrases be declared unconstitutional.

ADMINISTRATIVE DIVISION.

WALTER W. BRADLEY, Deputy State Mineralogist.

Personnel.

There have been no changes of personnel to be noted during the past quarter.

New Publications.

During the quarterly period covered by this issue, the following Bureau publications have been made available for distribution:

Mining in California (quarterly), January, 1927, being Chapter 1 of State Mineralogist's Report XXIII. Price 25 cents. This chapter contains reports on the mineral resources of Contra Costa County and of Santa Catalina Island; also a reprint of the report of the Hydraulic Mining Commission (including the map).

Summary of Operations. California Oil Fields: Vol. 12, No. 6, December, 1926, and Nos. 7 and 8, January and February, 1927, respectively.

Commercial Mineral Notes: Nos. 50, 51, 52. May-July (incl). These 'notes' carry the list of 'mineral deposits wanted' and 'minerals for sale' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'Mining in California.'

Mails and Files.

The Bureau maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During the period covered by this quarterly report, there were 1545 letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining, and developing mineral deposits, reduction problems, marketing of refined products, and mining law.



DIVISION OF MINERALS AND STATISTICS.

Statistics, Museum, Laboratory.

WALTER W. BRADLEY, Deputy State Mineralogist.

STATISTICS.

Data on the 1926 production of several of California's minerals were given in the April issue of MINING IN CALIFORNIA, and some additional ones are presented herein. Copy of the complete annual report for the year is now being prepared and will shortly go to the printer as Bulletin No. 100 of the State Mining Bureau.

COPPER.

Copper is second only to gold among the metals produced in California. The output for 1926 amounted to a total of 33,521,544 pounds of recoverable metal valued at \$4,693,014, a decrease from the 1925 figures of 46,968,499 pounds and \$6,669,527. The average price was slightly lower (14.0¢ per pound against 14.2¢) than in 1925. The 1924 price was 13.1¢ per pound.

As for several years past, Plumas County ranked first for 1926, with an output of 22,163,035 pounds; Calaveras, second, with 5,240,927 pounds; and Shasta, third, with 5,113,114 pounds; Shasta and Calaveras changing places compared with their 1925 positions.

Distribution of the 1926 copper output by counties was as follows:

<i>County</i>	<i>Pounds</i>	<i>Value</i>
Calaveras -----	5,240,927	\$733,730
Inyo -----	42,462	5,945
Mono -----	2,628	368
Plumas -----	22,163,035	3,102,825
Riverside -----	22,125	3,096
San Bernardino -----	171,232	23,972
Shasta -----	5,113,114	715,836
Trinity -----	760,140	106,420
Amador, Mariposa, Napa, Nevada, Orange, San Diego, Tuolumne * -----	5,881	822
Totals -----	33,521,544	\$4,693,014

* Combined to conceal output of a single operator in each.

GOLD.

The production of gold in California in 1926 totaled 576,798.40 fine ounces, worth \$11,923,481, being a decrease of 55,236.91 fine ounces from the 1925 yield. The 'deep' or lode mines accounted for \$6,695,078, and the placers (mainly the dredgers) produced \$5,228,403. As the State Mining Bureau has never independently gathered the statistics of gold and silver production, these figures, as in former years, are published by cooperation with and through the courtesy of Mr. J. M. Hill of the Division of Minerals and Statistics, U. S. Bureau of Mines.

The largest gold production for 1925 is reported from Yuba County with an output of 133,984.39 fine ounces (\$2,769,703); Nevada County with 112,174.19 ounces (\$2,318,846) was second; Amador County, 104,841.95 ounces (\$2,167,275), third; Sacramento County, 63,083.24 ounces (\$1,304,046), fourth; followed by Calaveras and Sierra counties in fifth and sixth places, respectively. It will be noted that Yuba County retained its position of first place, and that Nevada and Amador exchanged second and third, compared with the 1925 standing. The

Yuba County production is almost entirely from dredges, while that from Nevada and Amador is mainly lode gold.

Gold Production, by Counties, 1926.

<i>County</i>	<i>Value</i>	<i>County</i>	<i>Value</i>
Amador -----	\$2,167,275	Nevada -----	\$2,318,846
Butte -----	287,853	Orange -----	60
Calaveras -----	576,889	Placer -----	82,921
Del Norte -----	1,078	Plumas -----	247,667
El Dorado -----	91,789	Riverside -----	2,931
Fresno -----	8,595	Sacramento -----	1,304,046
Humboldt -----	1,243	San Bernardino -----	106,875
Imperial -----	238	San Diego -----	10,543
Inyo -----	26,871	Santa Cruz -----	143
Kern -----	135,508	Shasta -----	132,906
Lassen -----	67	Sierra -----	564,452
Los Angeles -----	94	Siskiyou -----	141,240
Madera -----	1,708	Stanislaus -----	127,398
Mariposa -----	182,313	Trinity -----	483,471
Modoc -----	158	Tuolumne -----	119,873
Mono -----	20,204	Yuba -----	2,769,703
Monterey -----	706		
Napa -----	7,817	Total value -----	\$11,923,481

LEAD.

Production of lead in California in 1926 increased slightly both in quantity and value over the preceding year. As in the past, the principal output was from lead-silver ores in Inyo County. The total recoverable lead in ores shipped from Californian mines in 1926 amounted to 8,067,873 pounds, valued at \$645,429, as against 7,352,422 pounds and \$639,661 in 1925. The average price of lead in 1926 was 8.0¢ per pound compared to 8.7¢ in 1925 and 8.0¢ in 1924.

The 1926 production was distributed by counties as follows:

Lead Production, by Counties, 1926.

<i>County</i>	<i>Pounds</i>	<i>Value</i>
Amador -----	1,267	\$101
Inyo -----	6,541,741	523,339
Los Angeles -----	1,104,507	88,361
Mono -----	20,906	1,672
Nevada -----	4,301	344
Orange -----	5,176	414
Riverside -----	173,207	13,857
San Bernardino -----	195,536	15,643
Shasta -----	15,584	1,247
Calaveras, Imperial, Plumas, San Diego, Siskiyou, Tuolumne*	5,648	451
Totals -----	8,067,873	\$645,429

* Combined to conceal output of a single operator in each.

PETROLEUM.

The crude oil production of California for 1925 amounted to a total of 224,673,281 barrels of clean oil, valued at \$345,546,677 at the well. This total of quantity is compiled from the monthly production reports filed by the operators with the State Oil and Gas Supervisor, to which have been added figures for the output of a number of small operators in the old Los Angeles City Field not under the jurisdiction of the Supervisor, and a small production in San Mateo County which was also not reported to that office.

The question of the value of the crude oil yield at the well is a difficult one to settle with exactitude, principally because a large part of the output is not sold until after refining. The large refiners are also large producers of crude oil which they send direct from well to plant, hence

much of the crude oil is not sold as such. The values used in the statistical reports of the State Mining Bureau since 1914 have been derived from averages of actual sales of crude oil of all grades in each field of the state, and these averages applied to the total yield of the respective fields. This we feel is a safer measure of commercial values than market quotations, because quotations do not always mean sales. This is particularly true on a rising or a falling market.

The following table gives the production and value by counties for 1926 compared with the 1925 figures:

County	1925		1926	
	Barrels	Value	Barrels	Value
Fresno -----	7,773,665	\$8,503,390	7,340,102	\$5,982,183
Kern -----	58,852,742	84,255,094	54,549,646	78,987,887
Los Angeles -----	121,214,551	173,215,593	105,826,337	174,084,324
Orange -----	32,734,420	46,384,673	37,989,349	59,225,395
San Luis Obispo-----	29,590	32,164	27,982	22,162
Santa Barbara -----	2,647,380	2,419,705	1,925,204	1,526,587
Santa Clara -----	13,828	22,594	^b	^b
Ventura -----	9,221,846	15,769,357	16,994,275	25,695,344
San Bernardino, and San Mateo -----	^a 4,125	7,259	-----	-----
Kings, San Bernardino, San Mateo, Santa Clara, Sonoma ^b -----	-----	-----	^b 20,386	22,795
Totals -----	232,492,147	\$330,609,829	224,673,281	\$345,546,677

^a Combined to conceal output of a single operator in San Bernardino County.
^b Combined to conceal output of a single operator in each.

The foregoing totals show a state average price of \$1.538 per barrel for the year 1926, as compared to \$1.422 in 1925 and \$1.200 in 1924.

Oil in 'Storage.'

Field, refinery, pipe-line, and tank-farm stocks of crude and refinery products in Pacific Coast territory totaled 145,612,176 barrels,¹ December 31, 1926, compared with 157,316,309 barrels on December 31, 1925. Of the 11,704,133 barrels decrease during the year, 8,214,864 barrels of tank-farm oils were destroyed by fire.

Stocks	Dec. 31, 1926 (Barrels)	Dec. 31, 1925 (Barrels) (Revised)
Heavy crude, heavier than 20° A.P.I., including all grades of fuel-----	88,707,499	86,519,383
Refinable crude, 20° A.P.I., and lighter-----	30,835,057	44,196,138
Gasoline -----	11,673,563	10,172,562
Naphtha distillates -----	3,832,042	6,548,483
All other stocks-----	10,564,015	9,879,743
Totals, all stocks-----	145,612,176	157,316,309

Proved Oil Land.

The total proved oil land of the state is 121,435 acres, a decrease during 1926 of one acre. Of this 1926 total, 22,493 acres, being owned by Federal, state and city governments, or for other reasons, is not assessable for the support of the Department of Petroleum and Gas of the State Mining Bureau. The acreage in 1926 was distributed by counties as follows:

¹ Standard Oil Bulletin, February, 1927, p. 15.

Proved Oil Lands and Number of Wells, 1926.

<i>County</i>	<i>Land (Acres)</i>	<i>Number wells Dec. 31, 1926</i>
Fresno -----	14,665	931
Kern -----	77,502	5,309
Los Angeles * -----	10,041	2,976
Orange -----	6,536	1,165
San Luis Obispo -----	402	18
Santa Barbara -----	7,394	291
Santa Clara -----	80	9
Ventura -----	4,815	579
Kings, San Bernardino, San Mateo, Sonoma -----	-----	3
Totals -----	121,435	11,281

*Not including the old Los Angeles City Field.

SILVER.

Except for the early-day production from the silver mines of the Calico district and the more recent production from those of the Randsburg area, both of which are in San Bernardino County, the recovery of silver in California has been largely as a by-product from its association with copper, lead, zinc, and gold ores.

The 1926 silver output of California totaled 2,022,460 fine ounces, valued at \$1,262,015, compared with 3,054,416 fine ounces, valued at \$2,106,871, in 1925. Of the 1926 yield, \$12,082 was from placers. The average price of domestic silver during 1926 was 62.4¢ per ounce in New York, as against 69.4¢ in 1925. The figures below are those of the U. S. Bureau of Mines, Department of Commerce (as explained under Gold).

The distribution of the 1926 silver yield by counties was as follows:

Silver Production, by Counties, 1926.

<i>County</i>	<i>Fine ounces</i>	<i>Value</i>
Amador -----	21,510	\$13,422
Butte -----	4,803	2,997
Calaveras -----	9,983	6,229
Del Norte -----	6	4
El Dorado -----	756	472
Fresno -----	84	52
Humboldt -----	10	6
Imperial -----	31	19
Inyo -----	124,508	77,693
Kern -----	7,479	4,667
Lassen -----	1	1
Los Angeles -----	68,362	42,658
Madera -----	35	22
Mariposa -----	2,433	1,518
Modoc -----	5	3
Mono -----	194,557	121,404
Monterey -----	5	3
Napa -----	81,116	50,616
Nevada -----	48,101	30,015
Orange -----	1,550	967
Placer -----	554	346
Plumas -----	347,147	216,620
Riverside -----	5,024	3,135
Sacramento -----	2,607	1,627
San Bernardino -----	884,045	551,644
San Diego -----	545	340
Santa Cruz -----	1	1
Shasta -----	177,434	110,719
Sierra -----	4,669	2,913
Siskiyou -----	1,137	709
Stanislaus -----	659	411
Trinity -----	21,275	13,276
Tuolumne -----	1,793	1,119
Yuba -----	10,235	6,387
Totals -----	2,022,460	\$1,262,015

ZINC.

Recoverable zinc in ores mined in California in 1926 amounted to 20,447,559 pounds, valued at \$1,533,568, compared with 11,546,602 pounds and \$877,542 in 1925. The bulk of the 1926 product came from Shasta and Los Angeles (Santa Catalina Island) counties and was shipped in the form of concentrates to Belgium. A portion of the output is used locally in the manufacture of lithopone, and a small amount of oxide is also made. The world situation as regards zinc was particularly favorable in 1926 to the American producer, and promises to continue so.

The average price per pound quoted for the metal in 1926 was 7.5¢, as against 7.6¢ in 1925 and 6.5¢ in 1924.

MUSEUM.

The Museum of the State Mining Bureau possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America; and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Mining Bureau as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

LABORATORY.

FRANK SANBORN, Mineral Technologist.

The public is earnestly invited to send such samples of minerals to this laboratory as may seem to have an economic or scientific value. The work is carried on without cost to residents of this state, and it is by means of these finds that the mineral wealth of the state is revealed. The possibilities of discovery of mineral of commercial value within the state are exceptionally favorable, and that the number of prospectors is on the increase is evidenced by the fact that the number of samples submitted to the bureau is steadily growing.

On account of the large number of samples received in the laboratory each day, it is necessary to make the reports brief. However, those who think that they may have a mineral deposit possessing commercial possibilities and who do not thoroughly understand what procedure should be taken in commercializing their prospect, are invited to ask any questions bearing on the subject.

During the three-month period covered by this report, 1157 samples were received and determined. Among this number there were considerable having commercial possibilities, judging from the samples received.

LIBRARY.

E. A. LOWE, Librarian.

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the State Mining Bureau contains some five thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, 'Mining in California' contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED.

Governmental.

U. S. Geological Survey:

Bulletin 786-B—Geology of the Cat Creek and Devil's Basin Oil Fields and Adjacent Areas in Montana. By Frank Reeves.

Bulletin 789—The Iniskin-Chinitna Peninsula and the Snug Harbor District, Alaska. By Fred H. Moffitt.

Bulletin 791—Geology of the Upper Matanuska Valley, Alaska. By Stephen R. Capps. Section on the Igneous Rocks. By J. B. Mertie, Jr.

Bulletin 792-A—Mineral Industry of Alaska, 1925, and Administration Report by Fred H. Moffitt.

Bulletin 792-B—Geology of the Knik-Matanuska District of Alaska. By Kenneth K. Landes.

795-A—Manganese Bearing Deposits near Lake Crescent and Humptulips, Washington. By J. T. Pardee.

795-B—Potash Brines in the Great Salt Lake Desert, Utah. By Thomas B. Nolon.

Bulletin 795-C—Organic Precipitation of Metallic Copper. By T. S. Lovering.

Professional Paper 148—Geology and Ore Deposits of the Leadville Mining District, Colorado, and maps accompanying same.

Water Supply Paper 549—Surface Water Supply of the United States, 1922, Part IX. Colorado River Basin.

Water Supply Paper 551—Surface Water Supply of the United States, 1922, Part XI. Pacific Slope Basin in California.

Water Supply Paper 557—Large Springs in the United States. By Oscar Edward Meinzer.

Water Supply Paper 575—Surface Water Supply of Hawaii, July 1, 1922, to June 30, 1923.

Water Supply Paper 584—Surface Water Supply of the United States, 1924, Part IV. St. Lawrence River Basin.

- Water Supply Paper 580—Contributions to the Hydrology of the United States, 1926.
 Water Supply Paper 583—Part III, Ohio River Basin.
 Water Supply Paper 568—Part VIII, Western Gulf of Mexico Basins.
 Water Supply Paper 569—Part IX, Colorado River Basin.
 Water Supply Paper 596-A—Methods of Exploring and Repairing Leaky Artesian Wells.
 Water Supply Paper 596-B—Quality of Water of Colorado River in 1925–1926.

U. S. Bureau of Mines:

- Bulletin 259—Placer Mining Methods and Costs in Alaska. By Norman L. Wimler.
 Bulletin 261—Resistance of Metal Mine Airway. By A. S. Richardson and G. E. McElroy.
 Bulletin 267—Acid Processes for the Extraction of Alumina. By G. S. Tilley, R. W. Millar and O. C. Ralston.
 Bulletin 268—Coal Dust Explosion Tests in the Experimental Mine, 1919–1924, inclusive. By George S. Rice, J. W. Paul and H. P. Greenwald.
 Bulletin 269—Quarry Problems in the Lime Industry. By Oliver Bowles and W. M. Myers.
 Bulletin 270—Production of Sponge Iron. By C. E. Williams, E. P. Barrett and B. M. Larsen.
 Bulletin 238—Subsidence Due to Coal Mining in Illinois. By C. A. Herbert and J. J. Rutledge.
 Technical Paper 391—Iron Blast Furnace Reactions. By S. P. Kinney, P. H. Royster and T. L. Joseph.
 Technical Paper 404—Identification of Oil-Field Waters by Chemical Analysis. By C. E. Reistle, Jr.
 Technical Paper 412—Accidents at Metallurgical Works in the United States during the Calendar Year 1925. By Wm. W. Adams.

Mineral Resources of the United States:

- Zinc in 1925 (Smelter Report). By Amy Stoll.
 Copper in 1925. By C. E. Julihn and Helena M. Meyer.
 Petroleum in 1925. By G. R. Hopkins and A. B. Coons.
 Cement in 1925. By B. W. Bagley.
 Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1925, Mine Report. By James M. Hill.
 Coke and By-products in 1924. By F. C. Tryon and others. With a Report on the Marketing of Coal Products. By R. S. McBride.
 Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1925. Mine Report by C. M. Gerry.
 Summary of Mineral Production in Foreign Countries, 1920–24. By L. M. Jones.
 Fullers Earth in 1925. By Jefferson Middleton.
 Sulphur and Pyrites. By Helena M. Meyer.
 Gold, Silver, Copper, Lead and Zinc in Arizona in 1925, Mine Report by V. C. Heikes.
 Part I, Metals, 1925.
 Part II, Nonmetals, 1925.
 Statistical Summary of the California Petroleum Industry, 1926. By E. T. Knudsen and J. W. Mashal.
 Petroleum Refineries in the United States, Jan. 1, 1927. By G. R. Hopkins.
 U. S. Coast and Geodetic Survey: Seismological Report, October, November, December, 1925, and Supplement for 1924.
 U. S. National Museum: Bulletin 131, The Minerals of Idaho. By Earl V. Shannon.
 California Fish and Game Law, April, 1927.
 California Libraries, News Notes of, April, 1927.
 Colorado Bureau of Mines, Annual Report of Year 1926.
 Connecticut, State of: Public Document No. 47.
 Florida Geological Survey: 17th Annual Report. Administrative Report Mineral Industries. History of Soil Investigations in Florida. Elevations in Florida. Structure and Stratigraphy of Florida.

Idaho Bureau of Mines and Geology :

Pamphlet No. 22. The Geology and Ore Deposits of the South Mountain Mining District, Owyhee, Idaho.

26th Annual Report of the Mining Industry of Idaho, 1924.

28th Annual Report of the Mining Industry of Idaho, 1926.

Illinois Geological Survey :

Report of Investigations No. 12, Limestone for Sewage Filter Beds.

Press Bulletin No. 9, Illinois Petroleum.

Directory of Illinois Operators to Accompany Mineral Industry Map, Jan. 1, 1927. Compiled by H. P. Christensen and E. Erb.

Kansas State Geological Survey :

Bulletin 10—Part I, the Geology of Russell County, Kansas, with Special Reference to Oil and Gas Resources. By W. W. Rubey and N. W. Bass.

Bulletin 10—Part II, Subsurface Correlation of the Stratigraphic Units from Russell County to Marin County. By M. N. Bramlette.

Bulletin 10—Part III, Fossils from Wells in Central Kansas. By Raymond C. Moore.

Bulletin 11—Geological Investigations in Western Kansas, with Special Reference to Oil and Gas Possibilities. By N. W. Bass.

Kentucky Geological Survey : Kentucky's Mineral Resources, 1927.

New York State Museum: Bulletin No. 273, 1927. The Mining and Quarry Industries from 1919 to 1924, including list of Operators.

North Carolina Department of Conservation and Development :

Economic Paper 58—Oil Prospecting Well Near Havelock.

Economic Paper 59—Oil-Bearing Shales of Deep River Valley.

Circular 16—The Power Situation in North Carolina, 1925.

Virginia Conservation and Development Commission, Geological Survey: Bulletin 27—Oil and Gas Possibilities at Early Grove, Scott County, Virginia. By Chas. Butts.

Societies and Educational Institutions.

Academy of Natural Sciences of Philadelphia, Pennsylvania. Year Book.

American Mineralogist, The—Journal of the Mineralogical Society of America: Vol. 12, May, No. 5; June, No. 6; July, No. 7.

Applied American Philosophical Society, Proceedings of the—Held at Philadelphia for the Promotion of Useful Knowledge, Vol. LXV, 1926. No. 5 Supplement.

California Academy of Sciences. Proceedings of the—4th Series, No. V to XVIII, April 22 to June 11, 1927.

Engineers Society of Western Pennsylvania, Proceedings of :

Vol. 43, No. 1. Feb., 1927.

Vol. 42, Feb. 26—Jan. 27.

Field Museum of Natural History: Publication 243, Vol. 7, No. 1, Annual Report of the Director of the Board of Trustees for the Year 1922.

Institution of Mining and Metallurgy: Bulletin 272, May, 1927.

Mining and Metallurgical Society of America: Bulletin 189.

Western Society of Engineers; Journal of the :

Vol. XXXII, No. 4, April, May, 1927.

Vol. XXXII, No. 5, June, 1927.

California, University of: An Eocene Invertebrate Fauna from the La Jolla Quadrangle, California. By Marcus A. Hanna.

Harvard University—Department of Mineralogy and Petrography :

Contributions to Mineralogy, No. 9—A Peculiar Manganiferous Serpentine from Franklin Furnace. By Earl V. Shannon and Esper S. Larsen.

Contributions to Mineralogy, No. 10—The Determination of Plagioclase Feldspars. By Roy W. Goranson.

Contributions to Mineralogy, No. 11—Meteorites in the Mineralogical Museum of Harvard University. By C. Palache.

Contributions to Mineralogy, No. 12—Catalogue of the Collection of Meteorites in the Mineralogical Museum of Harvard University. By Charles Palache.

Contributions to Mineralogy, No. 13—Barysilite from Franklin Furnace, New Jersey. By E. V. Shannon and H. Berman.

- Contributions to Mineralogy, No. 14—Uranium Minerals from Lusk, Wyoming. By E. S. Larsen, F. L. Hess and W. T. Schaller.
- Contributions to Mineralogy, No. 15—Hyalophane from Franklin Furnace, New Jersey. By L. H. Bauer and C. Palache.
- Contributions to Mineralogy, No. 16—A Note on Gyanotrichite. By Charles Palache and H. E. Vassar.
- Contributions to Mineralogy, No. 17—Cancrinite as a High Temperature Hydrothermal Mineral from Colorado. By Esper S. Larsen and William F. Foshag.
- Contributions to Mineralogy, No. 18—The Tulia Meteorite, Swisher County, Texas. By Charles Palache and John T. Lonsdale.
- Contributions to Mineralogy, No. 19—Lollingite from Franklin, New Jersey. By L. H. Bauer and H. Berman.
- Contributions to Mineralogy, No. 20—Aegirite from Libby, Montana. By Roy W. Goranson.
- Contributions to Mineralogy, No. 21—Memorial of Frederick Alexander Canfield. By Charles Palache.
- Contributions to Mineralogy, No. 22—The Occurrence and Properties of Chlorophoenicite. A New Arsenate from Franklin, New Jersey. By William F. Foshag, Harry M. Berman and Robert B. Gage.
- The Identity of Gilpinite and Johannite. Reprinted from the American Mineralogist, Vol 11, No. 1, January, 1926. By Esper S. Larsen and Harry Berman.
- Japan: Tohoku Imperial University, Sendai: Science Report. Second Series (Geology).
- Waseda University: Memoirs of the Faculty of Science and Engineering, No. 4, 1927.
- University Te Leiden, Leidsche Geologische Mededeelingen.
- McGill University, Montreal: Announcement of the Faculty of Applied Science for the Session of 1927-1928.
- Minnesota, University of, School of Mines Experiment Station:
- Mining Directory of Minnesota, 1927. By John J. Craig.
- Bulletin 12—Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry. By T. L. Joseph and S. P. Kinney.
- Sweden: The University of Upsala: Index to Bulletins of the Geological Institution of.
- Australia: Chamber of Mines of Western Australia, Kalgoorlie:
- President's Address and Election of Officers, Annual Meeting, March 29, 1927. Also Report of the Executive Council and Production Statistics for 1926.
- Western Australia Geological Survey Bulletin No. 91—The Auriferous Lodes of the Gibraltar District, Coolgardie Goldfield. By F. R. Feldtmann.
- Bulletin No. 88—Paleontological Contribution to the Geology of Western Australia, Series VII, Nos. XIII, XIV and XV. By Rex W. Bretnall, F. Chapman and Ludwig Glanert.
- Annual Progress Report of the Geological Survey of the Year 1925.
- Mining Review for Last Half of Year 1926, No. 45, Department of Mines, South Australia.
- Barcelona: Real Academia de Ciencias y Artes:
- Vol. XIX, Num. 15—La Determinacion Grafica del Desarrollo Intrazonal. By Dr. D. Francisco Pardillo.
- Vol. XIX, Num. 16—Apuntes Sobre el Colegio: Cofradia de San Elov do los Plateros de Barcelona, su Fin, y Evolucion del Oficio en esta Ciudad Hasta Nuestros Dias.
- Vol. XIX, Num. 17—Nota Comparativa Sobre el Calculo de las Grandes Cerchas Metalicas Estaticamente Determinadas e Interminadas.
- Vol. XX, Num. 1—De La Clasificacion en Malacologia.
- Memorias, Tomo XIX.
- Canada Department of Mines, Mines Branch: Abrasives, Products of Canada, Part II, Corundum and Diamonds. By V. L. Eardley-Wilmot.
- Part III, by V. L. Eardley-Wilmot.
- Canadian Mining and Metallurgical Bulletin No. 181.
- Bulletin No. 183, July, 1927.

Canadian Pacific Railway, Development Branch :

Arsenic.	Lead and Zinc.
Asbestos.	Limestone.
Barytes.	Lithium Minerals in Manitoba.
Bituminous Sands of Athabasca.	Magnesite.
Chromite.	Manganese.
Clay, Part I, Eastern Canada.	Mica.
Clay, Part II, Western Canada.	Mineral Water.
Clay, Part III, Fire and Ball.	Mining Situation in Canada.
Clay, Part IV, Kaolin or China Clay.	Molybdenum.
Coal, Part I, Eastern Canada.	Natural Gas.
Coal, Part II, Western Canada.	Nickel.
Cobalt.	Ochre (Iron Oxide).
Copper.	Peat.
Diatomaceous Earth (Tripolite).	Petroleum, Part I, Eastern Canada.
Feldspar.	Platinum and Related Metals.
Fluorspar.	Pyrites.
Forests, Part I, Eastern Canada.	Salt.
Forests, Part II, Western Canada.	Sand and Gravel.
Granite.	Silver.
Graphite.	Slate.
Gypsum.	Sulphates of Sodium and Magnesium.
Iron.	Talc and Steatite.

Lima (Peru) : Ministerio de Fomento ; Carbon y Fierro No. 1, Decretos.

Mexico :

- Revista Mensual de los Actividades Petroleros En Mexico. Secretaria de Industria, Comercio y Trabajo. Departamento de Petroleo, Febrero, Abril y Mayo, 1927.
- Bibliografia del Petroleo En Mexico, 1925.
- Indica Correspondiente al Volumen XXII, Del Boletin Del Petroleo, Julio a Diciembre de 1926.
- Boletin del Petroleo, Febrero de 1927.
- Boletin Minero, Junio de 1927.
- Su Aspecta Legal y su Reglamentacion por Jose Coloma y El Estado Actual de Esa Industrio por Gustavo Orgeto, 1927.
- Estradistica Nacional Revista, Quincenal, Marzo 30, Abril 15, Abril 30, Mayo 15.
- Estradistica Nacional Revista, Quincenal, 1927.
- Organo del Departamento de Minas, Boletin Minero, Tomo XXIII, Numero 4.

New Zealand Geological Survey :

- Bulletin No. 29—The Geology of the Egmont Subdivision, Taranaki. By T. J. Morgan and W. Gibson.
- Paleontological Bulletin 12—Contributions to the Paleontology of the New Zealand Trios.
- Ontario Department of Mines : 35th Annual Report, Parts I, V and VI.

Peru : Boletin del Cuerpo de Ingenieros de Minas del Peru, 108 :

Informe Sobre los Humos de la Oroya, 1926.

Philippine Journal of Science :

- Vol. XXXII, No. 4, April, 1927.
- Vol. XXXII, No. 1, May, 1927.

Poland :

- Statistics on the Mining and Metallurgical Industries for the Month of January, 1927. Ministerstwo Przemyslu i Handlu Departament Gorniczno-Hutniczy.
- Leidsche Geologische Mededeelingen Decl II, Aflevering 2. By Dr. B. G. Escher. Partly written in English.
- De la Societe Polonaise des Naturalistes Kopernik, Vol. LI. Geologia, Mineralogja i Petrografja.
- Rio de Janeiro : Boletin de Museu Nacional, Vol. II, No. 4, 1926.
- South Africa : President French's Address to the Transvaal Chamber of Mines, Mar. 28, 1927. Reprint from Mineralogical Magazine Dec., 1921. No. 95 : On Carnotite from Bwona Mkubwa, Northern Rhodesia.

U. S. S. Republic :

Scientific-Technical Department of the Supreme Council of National Economy.
No. 167—On the Uniformity of the Determination of Mechanical Properties of Sedimentary Rocks. By J. W. Samojloff.

On New Methods of the Mechanical Analysis and on Classification of Fractions.
By W. A. Silberminz and M. W. Klenowa.

No. 77—The Natural Iron Dyes. By I. Koubatoff.

No. 168—On Limestones of the Donetz Basin Containing Sulfuretted Hydrogen.
By W. A. Silberminz and K. F. Terentieva.

No. 138—Research Work of the X-Ray Department.

No. 184—Petrographical Description of the Valley of Soimonovsk. The Mountain Karabash. By E. A. Kouznetsov.

No. 139—Contributions to the Lythological Character of Sedimentary Rocks.
By J. V. Samojloff and L. V. Pustovaloff.

Economic Geology, Vol. XXII, No. 4, June and July, 1927.

Bituminous Sands of Alberta. By K. A. Clark.

Geology of the Cave-in Rock Quadrangle. By Stuart Weller.

Flora of the Chicago Region. By H. S. Bepoon.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

American Petroleum Institute, New York.

Architect and Engineer, San Francisco.

Arizona Mining Journal, Phoenix, Arizona.

Asbestos, Philadelphia, Pennsylvania.

Brick and Clay Record, Chicago.

Bulletin, Union Oil Co., Los Angeles.

California Journal of Development, San Francisco.

Cement, Mill and Quarry, Chicago, Illinois.

Chemical-Engineering and Mining Review, Melbourne, Australia.

Engineering and Mining Journal, New York.

Explosives Engineer, Wilmington, Del.

Financial Insurance News, Los Angeles, California.

Graphite, Jersey City.

Journal of Electricity and Western Industry, San Francisco.

Metallurgical and Chemical Engineering, New York.

Mine and Quarry, Chicago.

Mining and Engineering Record, Vancouver, B. C.

Mining and Oil Bulletin, Los Angeles.

Oil Age, Los Angeles.

Oil and Gas Journal, Tulsa, Oklahoma.

Oil and Gas News, Kansas City.

Oil News, Galesburg, Illinois.

Oildom, New York.

Oil, Paint and Drug Reporter, New York.

Oil Trade Journal, New York.

Oil Weekly, Houston, Texas.

Petroleum Age, New York.

Petroleum Record, Los Angeles.

Petroleum World, Los Angeles.

Queensland Government Mining Journal, Brisbane, Australia.

Rock Products, Chicago, Illinois.

Safety News, Industrial Accident Commission, San Francisco.

Salt Lake Mining Review, Salt Lake City, Utah.

Southwest Builder and Contractor, Los Angeles.

Standard Oil Bulletin, San Francisco.

Stone, New York.

The Record, Associated Oil Company, San Francisco.

Through the Ages, Baltimore.

Newspapers.

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, Cal.
Arkansas Oil and Mineral News, Hot Springs National Park (Arkansas).
Barstow Printer, Barstow, Cal.
Blythe Herald, Blythe, Cal.
Bridgeport Chronicle-Union, Bridgeport, Mono Co., Cal
Calaveras Prospect, San Andreas, Cal.
California Oil World, Los Angeles, Cal.
Cloverdale Reveille, Cloverdale, Cal.
Colusa Daily Sun, Colusa, Cal.
Daily Commercial News, San Francisco, Cal.
Daily Midway Driller, Taft, Cal.
Del Norte Triplicate, Crescent City, Cal.
Exeter Sun, Exeter, Cal.
Gateway Gazette, Beaumont, Cal.
Goldfield News, Goldfield, Nevada.
Guerneville Times, Guerneville, Cal.
Healdsburg Enterprise, Healdsburg, Cal.
Humboldt Standard, Eureka. Cal.
Inyo Independent, Independence, Cal.
Inyo Register, Bishop, Cal.
Ione Valley Echo, Ione, Cal.
Lake County Bee, Lakeport, Cal.
Mining and Financial Record, Denver, Colo.
Mining Topics, San Francisco, Cal.
Mountain Democrat, Placerville, Cal.
Mountain Messenger, Downieville, Cal.
Nevada Mining Press, Reno, Nevada.
Oatman Mining News, Oatman, Arizona.
Oregon Observer, Grants Pass, Oregon.
Oroville Daily Register, Oroville, Cal.
Petroleum Reporter, Taft, Cal.
Placer Herald, Auburn, Cal.
Plumas Independent. Quincy, Cal.
Plumas National Bulletin, Quincy, Cal.
Randsburg Times, Randsburg, Cal.
San Diego News, San Diego. Cal.
Shasta Courier, Redding, Cal.
Siskiyou News, Yreka, Cal.
Stockton Record, Stockton, Cal.
Tuolumne Prospector, Tuolumne, Cal.
Ventura Daily Post, Ventura, Cal.
Weekly Trinity Journal, Weaverville, Cal.
Western Sentinel, Etna Mills, Cal.



PRODUCERS AND CONSUMERS.

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of MINING IN CALIFORNIA, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list for MINING IN CALIFORNIA.



EMPLOYMENT SERVICE.

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

The Bureau registers technical men, or those qualified for supervisory positions, and vacancies of like nature, only, as no attempt will be made to supply common mine and mill labor.

A list of current applications for positions and 'positions open' is carried in each issue. Notices are designated by a key number, and the name and address corresponding to any number will be supplied upon request, without delay or charge of any kind. If desired, recommendations may be filed with an application, but copies only should be sent to the Bureau, to avoid possible loss. Registration cards for the use of both prospective employers and employees may be obtained at any office of the Bureau upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded.

POSITIONS WANTED.

- 51- 6 Superintendent. Five years' varied experience in California and Arizona. Age 33. Single. References. Salary, open.
- 51- 7 Superintendent. Thirteen years' experience in West. Age 47. Married. References. Salary wanted, \$250 minimum.
- 51- 8 Superintendent of Mine or Mill. Twenty-two years in Mexico and California in charge of gold and silver mines. Can design modern mills. Will accept half salary in stock of good property in California or Arizona. Age 44. Salary wanted, \$200 to \$500.
- 51- 9 Mill Superintendent or Foreman. Ten years' experience Mexico and Arizona. Age 38. Married. Salary, open.
- 51-10 Practical Hydraulic Miner.
- 51-11 Employment Manager, Time-keeper, Store-keeper, etc. Eight years' experience with Jackling interests. Age 34. Single. References. Salary, open.





PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU.

During the past forty-four years, in carrying out the provisions of the organic act creating the California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the state, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the Bureau's offices in the Ferry Building, San Francisco; New Orpheum Building, Los Angeles; Chamber of Commerce Building, Sacramento; Santa Maria; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states, and foreign countries.

A catalog of all publications of the Bureau, from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the offices of the State Mining Bureau and enclosing the requisite amount in the case of publications that have a list price. The Bureau is authorized to receive only coin, stamps or money orders, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the State Mining Bureau.

REPORTS.

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	-----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	-----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks-----	-----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks-----	-----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks-----	-----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	-----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	-----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. -----	-----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	-----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	-----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	-----

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892. 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.-----	\$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford-----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford -----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper-----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper-----	.50
Mines and Mineral Resources, Del Norte, Humboldt, and Mendocino Counties, 59 pp., paper-----	.25
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper-----	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper-----	.35
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper-----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou, and Trinity Counties, 974 pp., 275 illustrations, cloth -----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper -----	----
**Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter, and Tehama Counties, 91 pp., paper-----	----
Mines and Mineral Resources, El Dorado, Placer, Sacramento, and Yuba Counties, 198 pp., paper-----	.65
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties, 183 pp., paper-----	.65
Mines and Mineral Resources, Los Angeles, Orange, and Riverside Counties, 136 pp., paper-----	.50
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper -----	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report, Biennial Period 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper-----	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper-----	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper-----	.50
Seventeenth Report of the State Mineralogist, 1920, Mining in California during 1920, Fletcher Hamilton: 562 pp., 71 illustrations, cloth-----	1.75

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

Price

Eighteenth Report of the State Mineralogist, 1922, Mining in California, Fletcher Hamilton. Chapters published monthly beginning with January, 1922:

**January, **February, March, April, May, June, July, August, September, October, November, December, 1922----- Free

Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 ----- Free

Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy----- \$0.25

Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange counties----- .25

April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura counties----- .25

July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego counties ----- .25

October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara counties----- .25

Subscription, \$1.00 in advance (by calendar year, only).

Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz counties ----- .25

April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial counties ----- .25

July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties-- .25

October, 1926, Mines and Mineral Resources of El Dorado and Inyo counties, also report on Minaret District, Madera County----- .25

Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island----- .25

April, 1927, Mines and Mineral Resources of Amador and Solano counties-- .25

July, 1927, Mines and Mineral Resources of Placer and Los Angeles counties .25

Chapters of State Oil and Gas Supervisor's Report:

Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume) ----- Free

Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:

**April, **May, June, **July, **August, **September, **October, November, **December, 1919 ----- Free

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January, February, March, April, May, June, July, August, September, October, November, December, 1926----- Free

January, 1927 ----- Free

BULLETINS.

Asterisks (**) indicate the publication is out of print.

Price

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**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations-----	-----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps-----	-----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)-----	-----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations-----	-----
Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston. 85 pp., 46 illustrations-----	\$0.50
**Bulletin No. 7. Mineral Production of California, by Counties for the year 1894, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 8. Mineral Production of California, by Counties for the year 1895, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations-----	-----
**Bulletin No. 10. A bibliography Relating to the Geology, Palæontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.-----	-----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations-----	-----
**Bulletin No. 12. Mineral Production of California, by Counties for 1896, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 13. Mineral Production of California, by Counties for 1897, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 14. Mineral Production of California, by Counties for 1898, by Charles G. Yale-----	-----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899-----	-----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations-----	-----
**Bulletin No. 17. Mineral Production of California, by Counties for 1899, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations-----	-----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps-----	-----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899-----	-----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet-----	-----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet-----	-----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, and 9 maps-----	.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps-----	-----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 26. Mineral Production of California for the past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet-----	-----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps-----	-----
**Bulletin No. 28. Mineral Production of California, for 1902, by Charles G. Yale. Tabulated sheet-----	-----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet-----	-----

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**Bulletin No. 30. Bibliography Relating to the Geology, Palæontology, and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.-----	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet-----	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps-----	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet-----	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California-----	----
**Bulletin No. 36. Gold Dredging in California. by J. E. Doolittle. 1905, 120 pp., 66 illustrations, 3 maps-----	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905. 168 pp., 54 illustrations-----	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map-----	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet-----	----
**Bulletin No. 41. Mines and Minerals of California, for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps-----	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps-----	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.-----	----
Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.-----	\$0.30
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet-----	----
**Bulletin No. 48. Mineral Production of California for Twenty Years. 1906, by Charles G. Yale-----	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.-----	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman, 366 pp., 74 illustrations. (Revised edition.)-----	1.00
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, 1907, by D. H. Walker. Tabulated sheet-----	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker, 62 pp.-----	----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet-----	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker. 78 pp.-----	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations and 10 maps-----	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker, 1909. Tabulated sheet-----	----
**Bulletin No. 60. Mineral Production for 1909, County Maps and Mining Laws of California, by D. H. Walker. 94 pp.-----	----

BULLETINS—Continued.

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**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker, 1910. Tabulated sheet-----		----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps-----		----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.---		----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.---		----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp. -----		----
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp. -----		----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.-----		----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]-----		----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.-----		----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp., 4 illustrations-----		----
Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.-----		\$0.25
**Reconnaissance Geologic Map (of which Bulletin 72 is explanatory). in 23 colors. Scale: 1 inch = 12 miles. Mounted-----		----
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the fiscal year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations-----		----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations-----		Free
**Bulletin No. 75. United States and California Mining Laws, 1917. 115 pp., paper -----		----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring, 1918. 248 pp., 51 illustrations, 5 maps, paper-----		.50
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880-1917, by E. S. Boalich. 44 pp., paper-----		Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley, 1918. 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth-----		1.50
Bulletin No. 79. Magnesite in California, by Walter W. Bradley, 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth-----		1.00
Bulletin No. 80. Tungsten, Molybdenum and Vanadium in California. (In preparation.) -----		----
Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)--		----
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1916-1917, by R. P. McLaughlin, 1918. 412 pp., 31 illustrations, cloth-----		----
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**Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello, 1920. 124 pp., paper-----		----
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley, 1920. 204 pp., paper-----		Free
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leek, 1921. 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth-----		----

BULLETINS—Continued.

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Bulletin No. 91. Minerals of California, by Arthur S. Eakle, 1923, 328 pp., cloth-----	\$1.00
Bulletin No. 92. Gold Placers of California, by Chas. S. Haley, 1923. 167 pp., 36 photographs and 7 plates (colored and line cuts, also geologic map), cloth-----	1.50
Extra copies of the Geologic Map (in 4 colors)-----	.50
Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley, 1923, 188 pp., paper-----	Free
Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley, 1924, 162 pp., paper-----	Free
Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin, 1925. 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth-----	2.00
Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley, 1925. 173 pp., paper-----	Free
Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley, 1926. 172 pp., paper-----	Free

PRELIMINARY REPORTS.

Asterisks (**) indicate the publication is out of print.

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin. 4 pp.-----	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp.-----	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.-----	Free
Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper-----	Free
Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper--	Free
**Preliminary Report No. 6. A Review of Mining in California During 1919. Fletcher Hamilton, 1920. 43 pp. Paper-----	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper-----	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. Fletcher Hamilton, 1922. 68 pp. Paper-----	----

MISCELLANEOUS PUBLICATIONS.

Asterisks (**) indicate the publication is out of print.

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.-----	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.-----	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.-----	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.-----	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.-----	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.-----	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894.-----	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper-----	----

MISCELLANEOUS PUBLICATIONS—Continued.

Asterisks (**) indicate the publication is out of print.	Price
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper-----	Free
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 -----	Free

MAPS.

Register of Mines With Maps.

Asterisks (**) indicate out of print.

**Register of Mines, with Map, Amador County -----	----
**Register of Mines, with Map, Butte County -----	----
**Register of Mines, with Map, Calaveras County -----	----
**Register of Mines, with Map, El Dorado County-----	----
**Register of Mines, with Map, Inyo County -----	----
**Register of Mines, with Map, Kern County -----	----
**Register of Mines, with Map, Lake County -----	----
**Register of Mines, with Map, Mariposa County -----	----
**Register of Mines, with Map, Nevada County -----	----
**Register of Mines, with Map, Placer County -----	----
**Register of Mines, with Map, Plumas County -----	----
**Register of Mines, with Map, San Bernardino County -----	----
**Register of Mines, with Map, San Diego County-----	----
Register of Mines, with Map, Santa Barbara County (1906)-----	\$0.25
**Register of Mines, with Map, Shasta County -----	----
**Register of Mines, with Map, Sierra County -----	----
**Register of Mines, with Map, Siskiyou County -----	----
**Register of Mines, with Map, Trinity County -----	----
**Register of Mines, with Map, Tuolumne County -----	----
Register of Mines, with Map, Yuba County (1905)-----	.25
Register of Oil Wells, with Map, Los Angeles City (1906)-----	.35

OTHER MAPS.

Asterisks (**) indicate the publication is out of print.

**Map of California, Showing Mineral Deposits (50 x 60 in.)-----	----
**Map of Forest Reserves in California-----	----
**Mineral and Relief Map of California-----	----
**Map of El Dorado County, Showing Boundaries, National Forests-----	----
**Map of Madera County, Showing Boundaries, National Forests-----	----
**Map of Placer County, Showing Boundaries, National Forests-----	----
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**Map of Mother Lode Region-----	----
**Map of Desert Region of Southern California-----	----
Map of Minaret District, Madera County-----	.20
Map of Copper Deposits in California-----	.05
**Map of Calaveras County -----	----
**Map of Plumas County -----	----
**Map of Trinity County -----	----
**Map of Tuolumne County-----	----
Geological Map of Inyo County. Scale 1 inch equals 4 miles-----	.60
Map of California accompanying Bulletin No. 89, showing generalization of land with regard to oil possibilities. Map only, without Bulletin -----	.25
**Geological Map of California. 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted-----	----
Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92 (also sold singly). In 4 colors -----	.50

OIL FIELD MAPS.

These maps are revised from time to time as development work advances and ownerships change.

	Price
Map No. 1—Sargent, Santa Clara County-----	\$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos-----	.75
Map No. 3—Santa Maria, including Casmalia and Lompoc-----	.75
Map No. 4—Whittier-Fullerton, including Olinda, Brea Canyon, Puente Hills, East Coyote and Richfield-----	.75
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello-----	.75
Map No. 6—Salt Lake, Los Angeles County-----	.75
Map No. 7—Sunset and San Emido and Kern County-----	.75
Map No. 8—South Midway and Buena Vista Hills, Kern County-----	.75
Map No. 9—North Midway and McKittrick, Kern County-----	.75
Map No. 10—Belridge and McKittrick, Kern County-----	.75
Map No. 11—Lost Hills and North Belridge, Kern County-----	.75
Map No. 12—Devils Den, Kern County-----	.75
Map No. 13—Kern River, Kern County-----	.75
Map No. 14—Coalinga, Fresno County-----	1.00
Map No. 15—Elk Hills, Kern County-----	.75
Map No. 16—Ventura-Ojai, Ventura County-----	.75
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County-----	.75
Map No. 18—Piru-Simi-Newhall Oil Fields-----	.75
Map No. 19—Arroyo Grande, San Luis Obispo County-----	.75
Map No. 20—Long Beach Oil Field-----	1.25
Map No. 21—Portion of District 4, Showing Boundaries of Oil Fields, Kern and Kings counties-----	.75
Map No. 22—Portion of District 3, Showing Oil Fields, Santa Barbara County-----	.75
Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County-----	.75
Map No. 24—Portion of District 1, Showing Boundaries of Oil Fields, Los Angeles and Orange counties-----	.75
Map No. 26—Huntington Beach Oil Field-----	.75
Map No. 27—Santa Fe Springs Oil Field-----	.75
Map No. 28—Torrance, Los Angeles County-----	.75
Map No. 29—Dominguez, Los Angeles County-----	.75
Map No. 30—Rosecrans, Los Angeles County-----	.75
Map No. 31—Inglewood, Los Angeles County-----	.75
Map No. 32—Seal Beach, Los Angeles and Orange Counties-----	.75

DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

THE STATE MINING BUREAU
CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE
MINERAL RESOURCES OF CALI-
FORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the state, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the State Mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily.

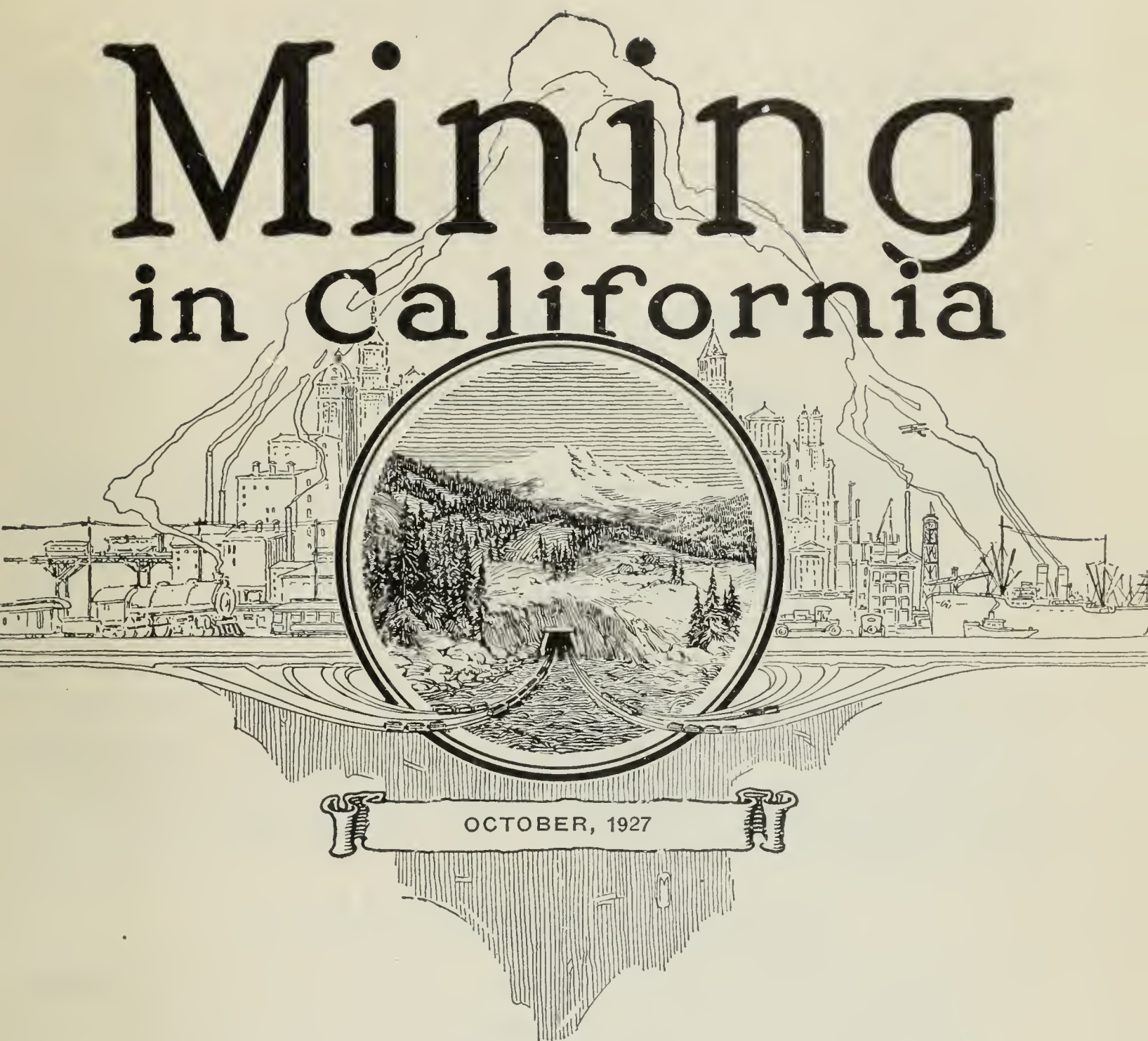
Saturday, 9 a.m. to 12 m.

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Mining in California



OCTOBER, 1927

PUBLISHED QUARTERLY

STATE OF CALIFORNIA
DIVISION OF MINES AND MINING

FERRY BUILDING
SAN FRANCISCO

DIVISION OF MINES AND MINING

EXECUTIVE AND TECHNICAL STAFF

LLOYD L. ROOT

State Mineralogist

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DEPARTMENT OF PETROLEUM AND GAS

R. D. BUSH, State Oil and Gas Supervisor	-	-	-	-	-	-	San Francisco
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NOTE.—A detailed report of the activities of the Department of Petroleum and Gas is issued monthly by the State Mining Bureau, entitled 'Summary of Operations, California Oil Fields.'

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINES AND MINING
FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT

State Mineralogist

Vol. 23

OCTOBER, 1927

No. 4

CHAPTER OF

REPORT XXIII OF THE STATE

MINERALOGIST

COVERING

MINING IN CALIFORNIA

AND THE

ACTIVITIES OF THE DIVISION OF MINES
AND MINING



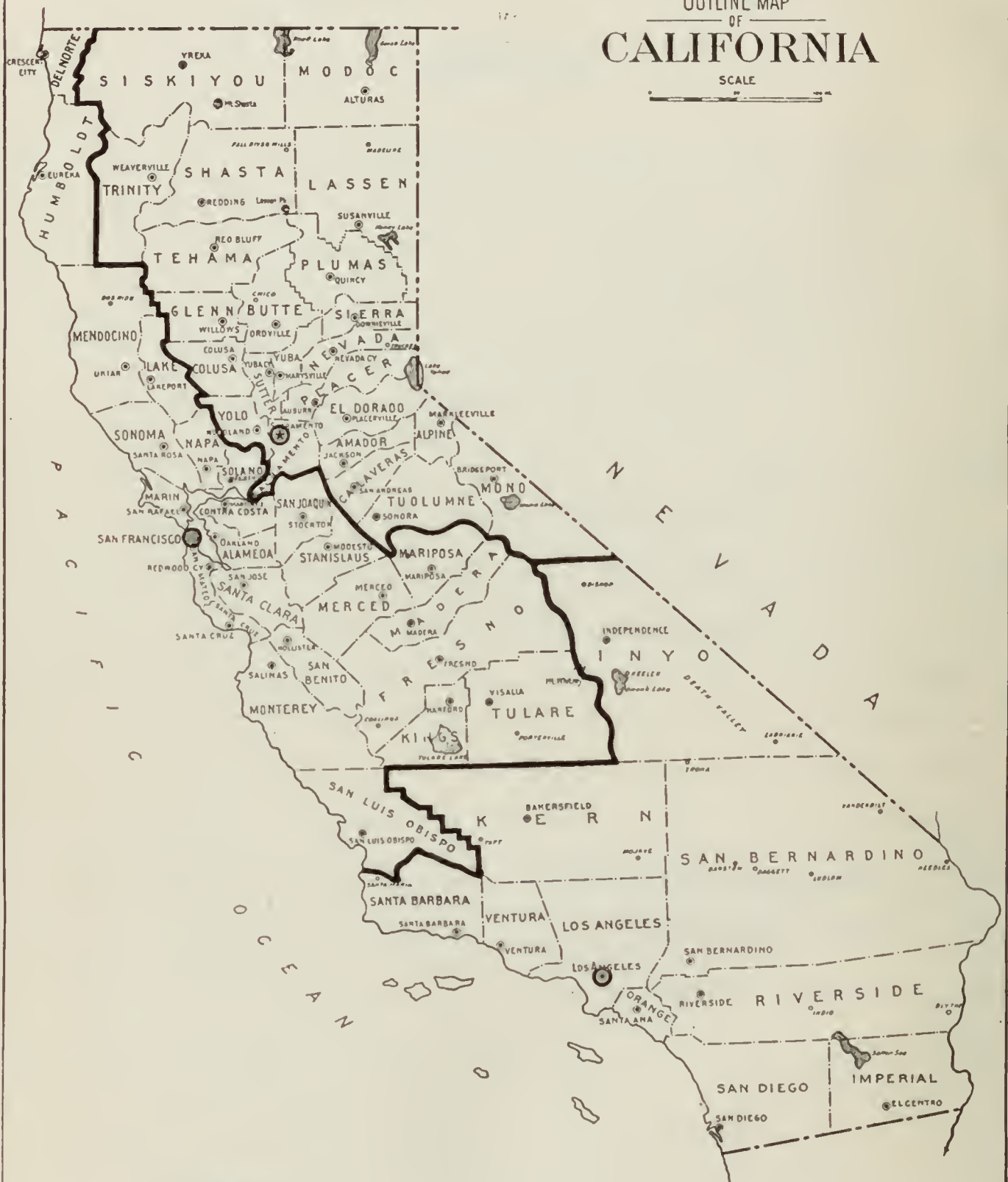
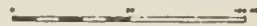
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State of California
DIVISION OF MINES AND MINING
LLOYD L. ROOT
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE



- LEGEND -

- Mining Division Boundaries
- Mining Division Offices.

MEXICO

PREFACE.

The Division of Mines and Mining (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

The weak point in work of this character has been that the results of field investigations were so long in preparation that they had lost much of their usefulness by the time they finally appeared in print.

As a progressive step in advancing the interests of the mineral industry, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923.

Owing to a lack of funds for printing this was changed to quarterly publication, beginning in September, 1923.

For the same reason, beginning with the January, 1924, issue, it has been necessary to charge a subscription price of \$1 per calendar year, payable in advance; single copies, 25 cents apiece. 'Mining in California' will continue to be sent without charge to our exchange list, including schools and public libraries, as are also other publications of the Division of Mines and Mining.

Pages are numbered consecutively throughout the year and an index to the complete reports is included annually in the closing number.

Such a publication admits of several improvements over the old method of procedure. Each issue contains a report of the current development and mining activities of the state, prepared by the district mining engineers. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance also are reported.

While current activities of all descriptions will be covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued, as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters will be subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines and Mining is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

DISTRICT REPORTS OF MINING ENGINEERS.

In 1919-1920 the Mining Department was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The boundaries of each district were adjusted and the counties now included in each of the three divisions, and the locations of the branch offices, are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the district engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the state's oil fields is included under this heading.

New County Reports.

The series of separate reports on the mines and mineral resources of the different counties, that together comprise the State Mineralogist's Reports XIV to XVII, inclusive, in the case of many of the counties have become exhausted. Those still in stock are in need of revision. It was deemed advisable, therefore, beginning with the January, 1925, issue of 'Mining in California,' to make the district engineers' reports in the form of a complete general report on the mines and mineral resources in one or more of the counties in each district.

This program will be followed as near as possible in succeeding numbers of the quarterly until each county in the state has been covered.

SACRAMENTO FIELD DIVISION.

C. A. LOGAN, Mining Engineer.

On account of unfinished field work there is no report from the Sacramento Field Division in this issue.

SAN FRANCISCO FIELD DIVISION.

C. MCK. LAIZURE, Mining Engineer.

On account of unfinished field work there is no report from the San Francisco Field Division in this issue.

LOS ANGELES FIELD DIVISION.

W. BURLING TUCKER, Mining Engineer.

MONO COUNTY.

Mono County was created April 24, 1861, and consists of 3030 square miles. It is bounded on the north and east by the state of Nevada, on the south by Inyo County and on the west by Madera, Tuolumne and Alpine counties. The county is extremely mountainous, the western portion lying among the Sierra Nevada Mountains, whose principal peaks rise to elevations of over 13,000 feet. The greater portion of the county, in its larger features, is a broad table land at an altitude of from 5000 to 7000 feet above sea level, traversed by a series of approximately parallel ranges running northerly and southerly, which rise several thousand feet above the plateau. The other prominent mountain ranges are the Sweetwater Mountains, along the eastern border of the county in its northern portion, and the White Mountains crossing its extreme southeast corner.

Mono Lake is the only large body of water in the county. It lies ten miles south of Bodie at an elevation of 6426 feet above sea level, with an approximate area of 1100 square miles. The water of this lake contains carbonate and sulphate of soda, sodium chloride, borax and other salts. A detailed description of this lake, by I. C. Russell, is contained in U. S. Geol. Survey Monograph XI, p. 267, 1885. The principal streams are Owens River, in the south, which rises in a high peak of the Sierras and flows southward, formerly emptying into Owens Lake, but at present whose waters are conveyed by an aqueduct as a supply for the city of Los Angeles; and the Walker River, which flows northward into Nevada. Mining and stock raising are the principal industries in the county.

The period of greatest activity in mining was from 1876 until 1888. The most productive gold districts have been Bodie, Masonic and Mono Lake. The principal production of silver has come from the Blind Springs Hill District, near Benton. The lack of railroad transportation has retarded the development of the highly mineralized belt that runs through the county. The only railroad in the county is the Nevada-California Railroad, which runs through the southeast corner of the county for a distance of 68 miles. In recent years the increase in travel during the summer months of the general public to the large number of pleasure resorts located in the high Sierra has led to the improvement of the main travel routes throughout the county.

General Geology.

The west boundary of the county, extending in a northwest direction from San Joaquin Peak to Topaz, is made up with deep-seated granitic rocks, including granites, diorites, granodiorites and gabbros, also metamorphic gneisses and schists. Included in this mass of granitic rocks, there is a belt of Cambrian limestones that extends from June Lake in a northerly direction to Virginia Creek. The central part of this belt of limestone is located west of Mono Lake, being about three miles in width on its southerly extremity, while at its northern limits it is about six miles wide. In the Mono Lake and Lundy districts, the belt is made up of metamorphic limestones, slates, greenstones and quartzites.

MONO COUNTY MINERAL PRODUCTION, 1880-1926.

Year	Gold, value	Silver, value	Lead		Lime		Miscellaneous and unapportioned		
			Pounds	Value	Barrels	Value	Amount	Value	Substance
1880-----	\$2,407,236	\$582,905							
1881-----	3,385,000	300,000							
1882-----	2,200,000	380,000							
1883-----	1,750,000	290,000							
1884-----	1,000,000	285,000							
1885-----	482,860	91,849							
1886-----	439,558	163,502							
1887-----	382,498	118,945							
1888-----	297,000	75,000							
1889-----	193,264	86,827							
1890-----	144,180	52,293							
1891-----	302,415	18,983							
1892-----	396,296	271,058							
1893-----	293,637	11,401							
1894-----	358,824	11,549	50,000	\$1,500					
1895-----	552,680	84,910	94,400	2,926			800 cu. ft.	\$8,000	Onyx.
1896-----	451,553	82,283	73,500	2,205	500	\$2,000	3,000 cu. ft.	24,000	Onyx.
1897-----	520,101	72,491	32,000	1,088	1,200	4,800			
1898-----	446,017	66,667	75,000	2,737	3,000	4,000			
1899-----	697,069	47,547	28,000	1,190	1,200	3,750			
1900-----	670,200	75,921	50,000	2,000	1,100	4,000			
1901-----	493,355	25,091	29,000	1,160	2,000	3,000	1,938 lbs.	305	Copper.
1902-----	510,596	36,548	4,400	154	2,000	2,000			
1903-----	334,713	20,067	1,000	36	1,818	5,000	1,600 lbs.	208	Copper.
1904-----	268,930	2,555			215	850			
1905-----	308,884	11,240							
1906-----	338,698	13,151							
1907-----	383,971	29,797							
1908-----	413,946	26,134					7,100 gals.	5,575	Mineral water.
1909-----	354,909	37,792						106,772	Unapportioned, 1900-1909.
1910-----	435,724	9,391							
1911-----	261,232	35,508	37,000	1,665					
1912-----	377,518	70,602	23,936	1,077	4,961	3,721	8,179 lbs.	1,350	Copper.
1913-----	147,271	23,263			2,135	1,600	79,319 lbs.	12,294	Copper.
1914-----	7,000	10,000					1,000 lbs.	150	Salt.
1915-----	107,302	1,923						200	Other minerals.
1916-----	237,084	3,606						300	Other minerals.
1917-----	209,040	5,662	1,912	164				3,906	Copper, molybdenum. salt.
1918-----	31,252	22,727	1,318	94			{ 160 lbs.	40	Copper.
								750	Other minerals.
1919-----	29,428	55,558	1,556	82			{ 539 lbs.	100	Copper.
							{ 3,215 lbs.	592	Copper.
1920-----	144,746	34,369	85,014	6,801				1,000	Miscellaneous stone.
								750	Other minerals.
1921-----	37,754	15,160	42,962	1,933			{ 2,940 lbs.	379	Copper.
								1,650	Onyx and salt.
1922-----	65,747	11,686	9,820	540			{ 4,333 lbs.	586	Copper
								8,304	Other minerals.
1923-----	34,661	3,120						10,000	Stone, miscellaneous.
								45,010	Other minerals.
1924-----	49,651	6,472	32,458	2,597				19,044	Stone, miscellaneous.
								48,927	Other minerals.
1925-----	5,503	1,590	22,488	1,957				29,250	Stone, miscellaneous .
								146,300	Other minerals.
1926-----	20,204	121,404	20,906	1,672			{ 2,628	368	Copper
								66,200	Other minerals.
Totals--	\$22,979,517	\$3,803,947	716,670	\$23,578	20,129	\$34,721		\$542,310	

The central and major portion of the county is covered by volcanic lavas and tuffs, chiefly andesites, but including some basalts and small amounts of rhyolite.

In this area the major portion of the ridges is made up of granitic rocks which strike northerly and are more or less parallel. Blind Spring Hill, which is located east of Benton, is made up of deep seated granitic rocks. The rock is a coarsely crystalline hornblende granite. This granite range is six miles in length from north to south and three miles in width from east to west. The White Mountain range is located in the southeastern end of the county, being a continuation of the Inyo range of mountains, and extends north from the Inyo County line into the State of Nevada. The White Mountain range is built up of a thick series of sedimentary rocks which are intruded by large masses of granite.

Mineral Resources.

Among the known mineral resources of the county are andalusite, barytes, clay, copper, dolomite, gold, lead, limestone, molybdenum, pumice, salt, silver, travertine and zinc.

METALS.

COPPER.

The base ores that occur in the well mineralized belt that follows the Sierra Nevada range very frequently carry copper in association with other minerals and some spasmodic attempts at mining this metal have been made in the past. The principal occurrences of copper ores are on Copper Mountain sixteen miles southwest of Bodie and four miles from the west shore of Mono Lake.

In this area copper ores are found on the contact of limestone and porphyry. The ore is principally azurite, cuprite, malachite and chrysocolla. No development work has been done on these deposits since 1908 and the extent of the deposits has not been determined. The antimonial silver ores of Blind Springs carry some copper, in the form of azurite, malachite and chalcopyrite.

GOLD.

The principal production of gold in Mono County has been from the Bodie, Masonic, Lundy and Mono Lake districts. The Bodie mining district has been the most important in Mono County and has a production record of about \$30,000,000 since its discovery in 1860. In this district the Standard Consolidated Mining Company's record of production from 1877 to 1913 was \$18,202,855, with \$5,264,407 paid out in dividends. The Southern Consolidated, which comprised the Noonday, Red Cloud, Addenda, Oro and Defiance mines, produced from 1877 to 1888, \$1,048,372. The Syndicate Mine record of production was over \$1,000,000. In the Lundy Mining District the May Lundy Mine has produced about \$2,000,000. The most productive mine in the Masonic District was the Pittsburg-Liberty Mine, which has a production record of \$700,000. Other important producing mines have been the Casa Diablo Mine, located in the Chidago District, and the Mammoth Mine, located near Mammoth in the high Sierra.



Lake Mono from the west side. Elevation 6426 feet (October, 1909, U. S. G. S.). Photo by Walter W. Bradley.

The principal gold placer areas in the county are located on the headwaters of the Walker River and on Virginia and Dog creeks, and the Bodie Diggins, located north of Mono Lake. Considerable gold was produced in the early days from the areas mentioned. The gravel in the area on Virginia and Dog creeks covers several hundred acres and is from five to ten feet thick, and said to have an average value of 25 cents per yard.

Mines.

Al Mono Mine. It is located in the West Walker River Mining District, in T. 8 N., R. 22 E., M. D. B. and M., 3 miles south of Coleville.

Bibl: State Mineralogist's Report XV, p. 165.

Blue Bird Group of Claims. It comprises 5 claims located in the Chidago Mining District, 12 miles southwest of Benton, a station on the Southern Pacific Railroad. Elevation 8500 feet. Owners, Harry M. Brown and J. F. Burchim, of Bishop, California.

A vein of quartz occurs in rhyolite, strikes northeast and dips vertically. A number of prospect holes made along the outcrop for a considerable distance have exposed a vein from 2 to 4 feet in width. Samples taken at the different openings are said to show values of \$5 to \$15 per ton in gold.

Bonanza Group of Claims. The group comprises five claims located in the Chidago Mining District, 4 miles north of the Casa Diablo District and 14 miles southwest of Benton, a station on the Southern Pacific Railroad. Elevation 7000 feet. Owner, Gerald Hartley, Bishop, California.

A vein of quartz 3 feet wide occurs in rhyolite. It strikes east and dips 70° south.

Development consists of a number of shafts sunk along the outcrops to depths of 10 to 20 feet. Samples taken from the different workings are reported to assay from \$5 to \$10 per ton in gold and silver.

Brownite Group of Claims. The group comprises three claims located 2½ miles southeast of Masonic, in the Masonic Mining District. Owner, W. L. E. Brown, of Masonic, California. The vein occurs on contact of schist and granite. It strikes northeast and has a width of 6 feet.

Bibl: State Mineralogist's Reports XV, pp. 143, 160; XVII, p. 153; XVIII, p. 416.

Casa Diablo Mine. It comprises six claims, two of which are patented, located 22 miles north and a little west of Bishop, Inyo County, in the Casa Diablo Mining District. Elevation 7200 feet. Owner, M. Q. Watterson, Bishop, California. The property was operated in 1921 and 1922 by the Bishop Community Gold Producers Mining Company, of Los Angeles.

Three parallel veins occur in granite, known as the May Brooks, Don of Hope and Dry Bone, the most productive vein being the May Brooks. These veins strike N. 55° E. and dip 65° northwest. In width the veins vary from 12 inches to three feet. The vein quartz is stained with iron oxide and shows only a small percentage of pyrite.

The workings consist of a number of tunnels driven at different elevations. The main working tunnel is known as the May Brooks tunnel and is driven as a crosscut S. 30° E., 1000 feet, intersecting the above mentioned veins. The May Brooks vein was intersected 300 feet from the portal of the tunnel. This vein was drifted on a distance of 300 feet southwest of crosscut and 75 feet to the northeast, and was stoped for a distance of 250 feet on the southwest to the surface. About 90 feet beyond the May Brooks, the Don of Hope vein was cut by the crosscut tunnel and this vein was developed for a distance of 300 feet to the northeast and stoped for a distance of 100 feet. About 30 feet southwest of crosscut tunnel, a winze was sunk on the vein to a depth of 250 feet. Approximately 100 feet beyond this vein the crosscut tunnel intersects the Dry Bone vein.

The average value of the ore milled from these workings is reported to have been \$12 per ton in gold.

Practically all the equipment, with the exception of a 10-stamp mill, has been removed from the property. Water for camp use and mill operations was secured from Rock Creek, a distance of eight miles. Idle.

Bibl: State Mineralogist's Report XVIII, p. 418.

Charlestown Mine. This property consists of 8 claims located in Sec. 36, T. 2 N., R. 25 E., M. D. B. and M., in the Mono Lake Mining District. Elevation 8700 feet. Owner, J. F. Hammond, of Mono Lake, California.

A vein of quartz occurs in slate and strikes northeast with a vertical dip. The vein quartz is 5 feet wide and is free milling.

Development consists of crosseuts and tunnels amounting to 900 feet. Idle.

Bibl: State Mineralogist's Reports VIII, p. 385; XII, p. 177; XIII, p. 227; XV, p. 172.

Chemung Mine. It is situated 2½ miles southeast of the town of Masonic, in the Masonic Mining District. Owner, Visalia Masonic Mining Company. George C. Cobb, president; Frank Carson, secretary, Visalia, California. Under lease to Burroughs and O'Brien, of Bridgeport.

Developments consist of a vertical shaft 200 feet in depth, with drifts on the 50, 100 and 200-foot levels. Three men employed in unwatering the shaft and underground workings.

Bibl: State Mineralogist's Report XVIII, pp. 415-416.

Clover Patch, Gold Lode, B. B. and Old Glory Groups of Claims. These groups comprise 52 claims, situated in T. 3 and 4 S., R. 30 and 31 E., in the Clover Patch and Chidago mining districts, located 35 miles north of Bishop and 14 miles southwest of Benton, a station on the Southern Pacific Railroad. Elevation 7000 to 8500 feet. Owner, *Universal Ore Milling and Mining Company*. Dr. E. W. Ames, president; W. H. Goodwin, secretary; W. B. Ames, general manager; Harry M. Brown, superintendent. Offices, Reno, Nevada.

Gold Lode Group comprises 16 claims; Old Glory Group comprises 19 claims; B. B. Group comprises 8 claims; Four Leaf Clover comprises 13 claims.

These claims are located along a series of parallel quartz lodes that strike N. 30° W., extending from the Casa Diablo Mine to Wildrose Canyon. The general country rock in this area consists of granite, rhyolite, quartzite, with here and there lentils of limestone. In places in this area, there are flows of andesitic tuff and some basalt. The quartz veins which occur both in granite and rhyolite are found along a series of parallel rhyolitic dikes that form the main ridges in this area, extending in a northerly direction. These veins vary in width from two to six feet.

Development consists of tunnels and shallow shafts and prospect holes along the most prominent outcrops. Samples taken from these different workings are stated to carry from \$2.50 to \$15 in gold and silver.

The most extensive development has been on the Old Glory Group which was formerly known as the Banner Mine. Here on the east slope of the ridge that lies east of Clover Patch, a tunnel has been driven 200 feet northwest on a vein that strikes N. 50° W. and dips 50° northeast. This vein is in granite and is from 18 inches to 3 feet in width. It is stated the ore mined from this tunnel had an average value of \$10 per ton in gold and silver.

South of these workings are the main Banner workings which consisted of several incline shafts sunk on a vein that strikes N. 30° W. and dips 15° west. These workings are caved. This vein has a width of 12 inches to 3 feet. The ore was hauled by wagon to Banner Springs where it was treated in a 5-stamp mill. The vein quartz is mineralized with galena, pyrite, marcasite and chalcopyrite and carries values in gold and silver.

On the Four Leaf Clover Group the gold occurs in fractures and seams in the rhyolite, the belt of rhyolite being about 2000 feet in width with general east and west strike. It is reported that the company has taken over the *Sierra Vista Mine* and plans to install a 50-ton mill for treatment of ores in the district.

Conroy Ranch (Placer). The property comprises 400 acres of patented land located on the north shore of Mono Lake and to the west of Mono Diggings.

The gravel on this property is reported to carry values of 25 cents per yard and covers the whole area of the ranch. It is reported that the property was formerly drilled for dredging ground. Richie Conroy, of Mono Lake, owner.

Dog Creek Placers. This area on Virginia and Dog creeks consists of well-rounded wash gravel, varying in depth from five to ten feet and distributed over several hundred acres of ground. It is stated that over this area the gravel will pan about 25 cents per yard. During the past year these placers have been worked by Laughlin and Rose, of Los Angeles. These parties are planning to install a shovel and also a screening and sluicing plant to work the gravels this winter.

Dunderburg Mine. It is situated one mile south of Green Creek, in Sec. 19, T. 3 N., R. 25 E., M. D. B. and M. Owner, J. S. Cain, of Bodie, California.

The vein occurs in granite, strikes north and dips 45° west. The vein is 3 to 9 feet in width and it is reported the oxidized ore above the upper tunnel carried values in gold as high as \$20 to \$40 per ton. The ore encountered in lower tunnel is highly mineralized with pyrite.

Development consists of three crosscut tunnels. The upper tunnel is 900 feet, and 200 feet below this tunnel there is a tunnel 1700 feet in length. About 800 feet below this latter, an adit was started on Green Creek and run 500 feet when operations were suspended. The property has been idle since 1902.

Bibl: State Mineralogist's Reports XII, p. 178; XIII, p. 227; XV, pp. 166-167.

El Dorado Group of Claims. This group of claims is located in Mammoth Lakes Mining District, 4 miles southwest of Mammoth P. O. on the west slope of the Sierra Nevada Range of mountains. Elevation 9400 feet. Holdings comprise five claims. Owners, D. F. Shively and associates, Mammoth, California.

The vein strikes northwest and dips 80° northeast. It has a width of 8 feet. The hanging wall of the vein is diorite-porphry, with quartzite on the footwall.

Development consists of shallow shafts and opencuts along the strike of the vein.

Golconda Mine. It is situated in $S\frac{1}{2}$ of Sec. 36, T. 2 N., R. 25 E., M. D. B. and M., in Mono Lake District, on the east slope of the range west of Mono Lake. Idle. Owner, *Nevada-California Power Company*.

Bibl: State Mineralogist's Report XV, p. 172.

Goleta Mine. It comprises seven patented claims located in Sec. 11, T. 2 N., R. 25 E., M. D. B. and M., on the eastern slope of the Sierras, about six miles northeast of Lundy. Owner, *Goleta Consolidated Mining Company*. Elevation, 7500 to 8500 feet. Developments consist of two tunnels. The upper tunnel is 1200 feet in length, while the lower tunnel is said to be 500 feet in length. The vein quartz carries values in gold, silver and copper. Idle.

Bibl: State Mineralogist's Reports XII, p. 178; XIII, p. 228; XV, p. 172.

Golden Gate Mine. It is located in Rodriguez Canon, about three miles from Coleville, in Sec. 26, T. 8 N., R. 22 E., M. D. B. and M. Owner, Brown and Donovan, of Masonic. Two veins of quartz occur in schist, strike N. 60° E., and dip 38° . Veins vary in width from two to four feet. Developments consist of five tunnels from 300 to 1800 feet in length. Idle.

Bibl: State Mineralogist's Report XV, pp. 140-142 and p. 165.

Gold Wedge Mine. It comprises nine claims located on the east slope of the Benton Range of mountains, 1.1 miles southwest of Benton. Owner, Joseph Main of Benton, California. Under bond and lease to R. E. Davis and J. A. Mayer, of Bishop, California. There are two systems of veins on the property. One strikes N. 20° E., and dips 50° west. The other strikes east and dips north. These veins occur in schist and are from two to four feet in width. The vein quartz is mineralized with pyrite, galena, marcasite and carries values in gold and silver. On a ridge, at an elevation of 7100 feet, a tunnel has been driven south 175 feet on the N. 20° E. vein. At 150 feet from the portal, the tunnel intersected an east and west vein and a drift has

been driven 40 feet east on this vein. The vein worked was 18 inches in width. Eighty-four tons was shipped from these workings which it is stated carried 50 oz. in silver and \$8 per ton in gold. At an elevation of 6800 feet a crosscut tunnel is being driven south to intersect these veins. The tunnel is in 300 feet. On the north side of the canyon are several tunnels 50 to 100 feet on a vein that strikes N. 20° E. and dips 50° west. Six men are employed.

Headlight and Monte Cristo Mine. This property comprises six claims located in the Mammoth Lakes Mining District, 4½ miles southwest of Mammoth. Elevation 9100 feet. Owner, P. Reddy Estate, of San Francisco. Under option to *Mammoth Consolidated Mines Company*, Terminal Subway Building, Los Angeles.

These mines are situated on a ridge north of Mammoth Creek and are located between the Mammoth and Lisbon mines.

Development consists of a crosscut tunnel driven west 1500 feet, at a depth of 800 feet below the surface.

It is stated that a vein of low grade quartz was cut at a distance of 1200 feet from the portal. Idle.

Bibl: State Mineralogist's Reports VIII, p. 375; X, p. 341; XII, p. 181.

Hermine Mine. It comprises one claim situated in the Masonic Mining District, in Sec. 15, T. 6 N., R. 26 E., M. D. B. and M. Owner, Mrs. Homer Grigsby, Masonic, California.

Bibl: State Mineralogist's Report XV, p. 164.

Home View Mine. It is situated in the Masonic Mining District, in Sec. 15, T. 6 N., R. 26 E., M. D. B. and M., north of the Pittsburg Liberty Mine. Tunnel driven south 900 feet in granite. Idle.

Bibl: State Mineralogist's Report XV, p. 164.

Hornet Group of Mines. This group is located 8 miles southwest of Benton in the Benton Range of mountains, south of the Tower Mine. The property was formerly known as the *Yellow Jacket Mine*. Holdings comprise four claims. Owners, Harry M. Brown and J. F. Burchim of Bishop, California. Elevation, 6350 feet. The main Yellow Jacket vein strikes N. 30° E., dip vertical. Width 2 to 4 feet. The vein occurs on the contact of schist and granite. There is also a vein in granite that strikes east and dips 50° north. This vein has a width of 2 feet. Development consists of a shaft 150 feet deep and a number of tunnels and shallow shafts. Idle.

Lake View Mine. It comprises one claim, situated in Sec. 20, T. 26 N., R. 26 E., in the Masonic Mining District. Owner, J. M. Bryan Estate of Masonic. Development consists of a tunnel 175 feet in length with winzes and raises on the vein. Idle.

Bibl: State Mineralogist's Report XV, pp. 164-165.

Leida Group of Mines. This group of mines is situated two miles west of Deer Springs, and 12 miles southwest of Benton, in the Benton Range of mountains and in the Chidago Mining District. Holdings comprise 16 claims. Owner, Louis Leida of Benton, California. Elevation 8000 feet. A series of parallel veins occur on these claims, which



Photo showing Mammoth Consolidated Mines Company's property.

strike northwest and dip 50° southwest, in granite. The veins have a width of 3 to 6 feet. Development consists of a number of tunnels and open cuts along the outcrops. Two men employed.

Lisbon Mine. It comprises a group of 8 claims located on the ridge northeast of Mammoth Creek, in the Mammoth Lakes Mining District, about 5 miles southwest of Mammoth P. O. Elevation 9500 feet. Owners, Earl C. Dart and Frank Butler, of Mammoth. This, with the Mammoth Mine, was one of the original producers from 1878 to 1884.

The vein is from two to six feet wide, and strikes N. 30° E. and dips 70° southeast. The vein was developed by three tunnels about 100 feet apart. It is stated that Lisbon vein faults the Mammoth vein. The ore was free-milling gold quartz, with more or less auriferous pyrite. The ore was formerly treated in a 5-stamp mill, located below No. 3 tunnel. Workings caved.

Log Cabin and Sunrise Group of Mines. This group of mines comprises 17 claims located in Sec. 1, T. 1 N., R. 25 E., M. D. B. and M., on the east slope of the Sierra Nevada Range and $2\frac{1}{2}$ miles west of Mono Lake. Owners, J. R. Simpson and Luther Brown, of Los Angeles. Elevation, 9000 feet. The country rock is a metamorphic slate and quartzite. On the Log Cabin group, which comprises five claims, there are five parallel veins that strike north. Several of these veins dip 70° east. The others dip 45° west. The widths of the veins vary from 2 to 3 feet.

Development consists of shafts and tunnels. The lower tunnel is driven south 700 feet, and 400 feet in elevation above this tunnel is another tunnel driven south 160 feet and about 1000 feet east of this tunnel at a higher elevation are two shafts; one 100 feet deep and the other 250 feet in depth. This latter shaft was sunk in the footwall. On the 100-foot level a drift runs north on the vein for a distance of 60 feet. There is also a crosscut driven east on the 100-foot level 100 feet, which cuts three parallel veins whose average width is four feet, and it is stated that ore from these workings carried \$10 to \$20 per ton in gold. There are a number of other shafts from 50 to 100 feet in depth. The ore is oxidized quartz, showing free gold and some hematite. On the Sunrise Group of Claims, which are located on the east slope of the ridge overlooking Mono Lake, there are two systems of veins. One strikes east and west; the other north and south. The country rock is limestone, with thick beds of shale and slate. The north and south vein dips 45° west and most of the development work has been confined to this vein.

Development consists of four tunnels. The lower tunnel is driven S. 20° W., 600 feet and at 400 feet cuts the east and west vein. The vein quartz carries values in gold, silver and lead. The hanging wall of the vein that strikes north is slate, with a limestone footwall. The vein is two to three feet in width. At an elevation of 300 feet above this tunnel, there is a tunnel driven south on the vein a distance of 100 feet. The ore from these workings is stated to carry \$12 per ton in gold, 40 ozs. in silver and 20 to 40% in lead. About 80 feet above this tunnel, there is a shaft sunk on the vein to a depth of 30 feet and a tunnel 50 feet in length is driven on the vein. The vein here is four to five feet wide. Above these workings is another tunnel, driven south 70 feet to an east and west vein, which has a width of two feet, and is reported to carry high values in gold.

Equipment consists of a 2-stamp mill and bunk house. Four men are employed on development.

Bibl: State Mineralogist's Report XV, p. 171.

Lost Horse Mine. It comprises one claim situated in Sec. 20, T. 6 N., R. 26 E., M. D. B. and M., in the Masonic Mining District. Owner, J. D. Martin, of Masonic. Shaft 50 feet deep and trenches along an iron-stained outcrop of quartzite. Idle.

Bibl: State Mineralogist's Report XV, p. 164.

Mammoth Mine. It is situated in the Mammoth Lakes Mining District, in Secs. 9 and 10, T. 15, 16 S., R. 27 E., M. D. B. and M., 4 miles southwest of Mammoth P. O., on the west slope of the Sierra Nevada range of mountains. Elevation 9000 to 10,000 feet. Owner, *San Francisco and Fresno Land Company*, of San Francisco, California.



Outcrop of vein. Mammoth Consolidated Mining Co., Mammoth, Mono County.

Under option to the *Mammoth Consolidated Mines Company*, 1241 Terminal Subway Building, Los Angeles. E. S. Gillette, president; A. G. Mahan, Jr., secretary; A. G. Mahan, general manager.

Holdings formerly comprised five claims known as Folk, Armstrong, San Francisco, Big Bonanza and Mammoth, two of which are patented. The property was operated by the *Mammoth Mining Company*, of San Francisco, from 1878 until 1881. The production during this period amounted to \$200,000 in gold. The Mammoth vein occurs in crystalline rocks, evidently due to alteration of the slates and has a general northwesterly course, dipping 70° to 80° to the northeast. The surface croppings show the vein to be over 100 feet in width. The gold is reported to occur in bunches and spots, and the vein material is mineralized with magnetite, oxides of iron, auriferous pyrite, chalcopyrite, sphalerite and native gold. The bullion produced from this mine when under operation is reported to have been valued at \$7 to \$16 per ounce.

The underground workings consist of four tunnels, all over 1500 feet in length. The orebody is developed to a depth of 1000 feet below

the outcrop. The orebody that was worked between tunnels No. 2 and No. 3 is stated to have been 14 to 40 feet in width. The orebody worked was 500 feet above No. 4 tunnel. The present development work on the property is being confined to cleaning out and retimbering tunnels No. 2 and No. 3. Tunnel No. 3 which is driven S. 30° E. encountered the vein 800 feet from the portal and followed the hanging wall for a distance of 700 feet. Two upraises connect with a large stope which extends to No. 2 tunnel 200 feet above No. 3 tunnel. It is stated that samples taken from this stope carried \$9 per ton in gold. There is an intermediate level 50 feet below No. 2 tunnel, and here is a stope 240 feet in length, and 30 feet wide. This stope is 240 feet from the portal of No. 2 tunnel.

The principal development operations of the company are confined to seven claims known as the Friendship Group, which are located on the ridge northeast of Mammoth Creek about 1½ miles southwest of the Mammoth Mine. The first discovery of high grade gold ore was made by D. F. Shively, of Mammoth, in 1918, and these claims were taken over by the Mammoth Consolidated Mines in August, 1927, and active development work started.

The principal rocks of this area are dioritic porphyry, and belts of crystalline rocks to the north and south of Mammoth Creek, with granite to the south. The top of the ridge is capped with andesite. The mineralization is principally confined to a belt of crystalline rocks which is about 500 feet wide and has a general northwest course.

The gold values are found along fractures in this belt of crystalline rock.

On this group of claims, a crosscut tunnel is being driven N. 55° E. At the time of visit the tunnel was in 75 feet. The rock in this tunnel is highly silicified and heavily mineralized with pyrite, pyrrhotite, sphalerite and some chalcopyrite.

On Friendship No. 5 Claim, which is located north of Mammoth Creek Falls, there is a vein of quartz 6 to 8 feet wide, which occurs in an andesite-porphyry, that is mineralized with argentite, pyrite and sphalerite. It also shows some native silver. Samples taken from this vein are reported to carry 17 ozs. in silver and \$8 per ton in gold.

Equipment consists of a 250-cu. ft. Ingersoll-Rand compressor, blacksmith shop, cars and air drills. Fifteen men are employed.

Bibl: State Mineralogist Report VIII, pp. 373-375.

Mary B. Group of Claims. It comprises four claims situated in the Chidago Mining District, in the Benton range of mountains, 12 miles southwest of Benton. Owners, Harry Brown and J. F. Burchim, of Bishop, California. The country rock is rhyolite. A vein of quartz from 4 to 6 feet in width strikes east and dips 60° north. The only development consists of shallow shafts and open-cuts on the outcrop of the vein. Idle.

May Lundy Mine (Crystal Lake). It is situated on the south slope of Mount Scowdon, in Sec. 30, T. 2 N., R. 25 E., M. D. B. and M., five miles south of Lundy and six miles west of Mono Lake P. O. in the Homer Mining District. Elevation, 9500 to 12,500 feet. Owners, Thomas Hanna and R. T. Pierce, of Martinez, California. The deposit was discovered in 1879 and operated continuously from that

date until 1898. Since then it was operated at intervals until 1914. The total production is reported to have been from \$1,700,000 to \$2,000,000. Holdings comprise one patented claim and about 20 claims held by location.

The country rock is slate and hornblende granite. Two veins, known as the May Lundy and West veins, occur in hornblende granite. These veins strike northwesterly and dip 45° to 50° southwesterly and are 2 to 4 feet wide. The lode is developed by a number of tunnels, drifts, shafts and winzes. Tunnels No. 1, No. 2 and No. 3 were driven on the lode, the latter being over 1000 feet in length. The Lake View crosscut tunnel, 3100 feet in length and 200 feet in elevation below, is the main adit tunnel which is 3900 feet in length, and cuts the May Lundy Vein 1500 feet below the outcrop. The vein quartz carries free gold and some pyrite. There is a 20-stamp mill on the property, situated near the main adit. Idle.

Bibl: State Mineralogist's Reports VIII, p. 371; XII, p. 180; XIII, pp. 228-229; XV, pp. 170-171.

New Bodie (Syndicate) Mine. It is situated in the Bodie Mining District, and adjoins the Standard Consolidated Mining Company's holdings on the north. Idle.

Bibl: State Mineralogist's Reports VIII, p. 387; XII, p. 184; XIII, p. 232; XV, pp. 159-160; Report of the Director of the U. S. Mint, 1883, p. 175.

New York Mine. It is situated in the Masonic Mining District, and adjoins the Serita Mine. Idle.

Bibl: State Mineralogist's Report XV, p. 164.

Paragon Group of Claims (Gold). This group is situated in the Indian Mining District, 8 miles south of Benton. Elevation 7750 feet. Holdings comprise 5 claims. Owners, George L. Wallace and S. N. Looney, of Benton.

The vein occurs as a prominent outcrop of quartz, having a width of 30 feet. It strikes north and dips 80° west. The country rock is granite and rhyolite.

A sample taken across 30 feet is reported to carry \$7 per ton in gold.

Development consists of two tunnels; the upper tunnel is driven south a distance of 50 feet, about 50 feet below the outcrop. About 25 feet below this tunnel, the lower tunnel has been driven as a crosscut in the granite footwall 100 feet to the vein. The property was formerly owned by Pat Ready and is reported to have had some production.

Parrett Mine. It is situated in Sec. 19, T. 2 N., R. 25 E., M. D. B. and M., one mile west of Lundy and eight miles northwest of Mono Lake post office. Holdings comprise 11 claims. Owner, Hillis Parrett, of Mono Lake, California. Idle.

Bibl: State Mineralogist's Reports XII, p. 182; XIII, p. 230; XV, p. 172.

Pittsburg-Liberty Mine. It comprises four claims, known as Pittsburg, Liberty, Liberty No. 2 and Pittsburg No. 2, located in Secs. 21

and 22, T. 6 N., R. 26 E., M. D. B. and M., in Masonic Mining District, 12 miles northeast of Bridgeport. Elevation 8000 feet. Owner, *Valley View Mining Company*, Reno, Nevada.

Five parallel veins occur in schist, strike N. 25° W., dip 70° to 90° east.

Developments consist of a shaft 172 feet deep and two tunnels cutting the veins at a depth of 271 feet and 413 feet. The total amount of development consists of 6000 feet of underground workings. The property is reported to have a production of \$700,000.

Equipment consists of 100-hp. gas engine and 60-ton mill and cyanide plant. Idle.

Bibl: State Mineralogist's Report XV, pp. 161-162.

Rancheria Placers. It comprises 160 acres located 6 miles west of Mono Lake. Elevation 7300 feet. Owner, W. R. Hunnewell, Bridgeport, California. Under option to *Sin Placer Mining Company*, of Los Angeles. H. B. Franks, Richard Ward and F. M. Keyser. Besides the 160 acres held under option, the company has located a number of other claims.

The Cinnamon cut is located on the Hunnewell property. This cut is 1700 feet in length by 200 feet wide and 75 feet deep. The gravel was washed in former days by water secured through a ditch from Virginia Creek, and it is reported that the production of gold from this cut was over \$80,000. The source of the gold in this area is from ledges and stringers, as the gravel is fine and more or less angular, with no boulders.

In Rancheria Gulch, a number of shafts have been sunk to depths of 30 to 40 feet to bedrock in the center of the gulch. The gravel is said to run from 25¢ to 80¢ per cu. yd. The area in which the placers are located was known as Bodie Diggings.

Red Rock Mine. It is located in Sec. 20, T. 6 N., R. 26 E., M. D. B. & M., in the Masonic District, 12 miles northeast of Bridgeport. Owners, J. D. Martin, Robert Batcher, Verne Smith, of Santa Rosa, California.

Developments consist of shaft 50 feet deep and several tunnels about 25 feet in length. Idle.

Bibl: State Mineralogist's Report XV, p. 165.

Reo Group of Claims. It comprises eight claims located one mile north of the Sierra Vista Mine, in the Chidago Mining District. Elevation 7450 feet. Owner, R. J. Hess, of Bishop, California. Under option to G. Blakemore and associates, of Reno, Nevada.

The vein strikes N. 20° W. and dips 80° west, and has a width of 3 feet. The hanging wall of the vein is schist, with rhyolitic porphyry on the footwall.

Developments consist of shallow shafts and short tunnels. Idle.

Rough and Ready Mine. It is situated in the Masonic District, 12 miles northeast of Bridgeport. Developments consist of two tunnels 300 and 350 feet in length. Idle.

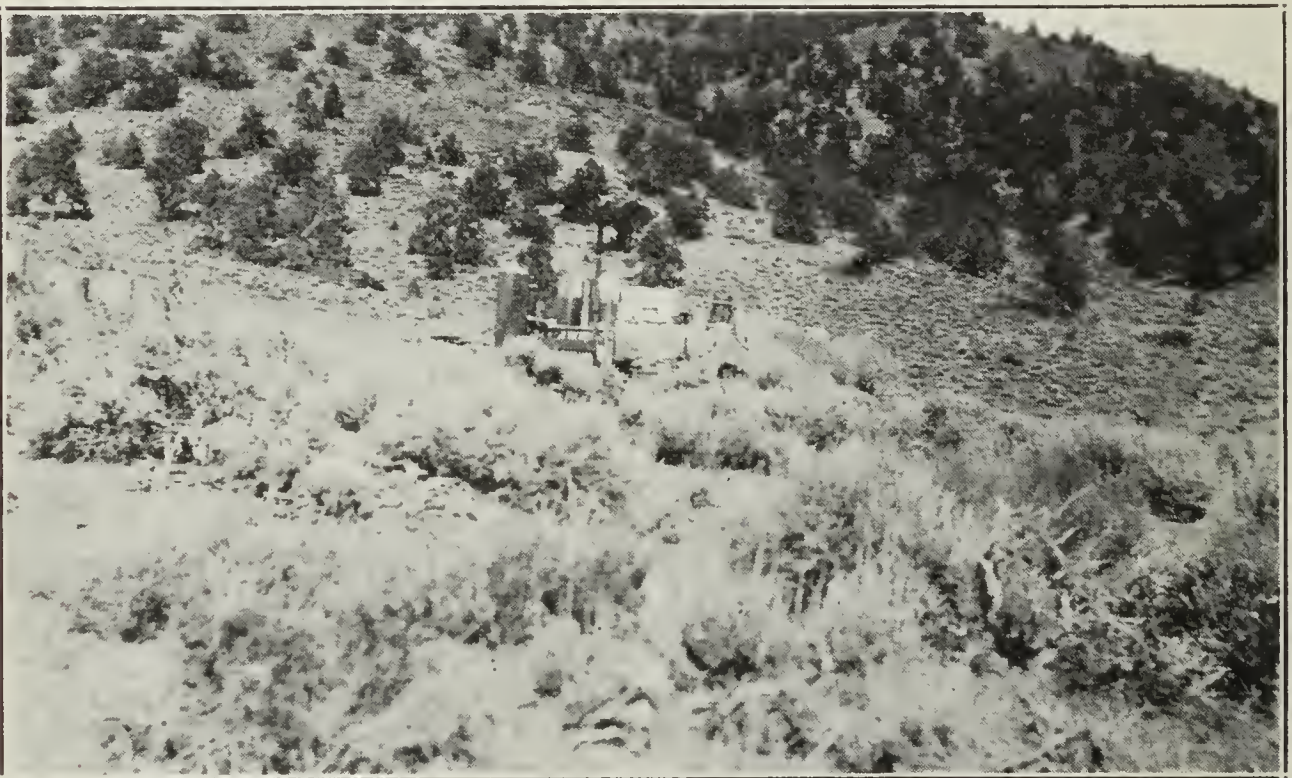
Bibl: State Mineralogist's Report XV, p. 164.

Sacramento Mine. It comprises four claims located on the west slope of the White Mountains, 11 miles north of Laws and 3 miles northeast of Chalfant Siding, on the Southern Pacific Railroad. Elevation 6000 feet. Owner, Chas. Gifford, of Laws, California.

The vein occurs in granite, having an east and west course, and dips 30° north. The width varies from 18 inches to 4 feet.

Development consists of a tunnel 300 feet long, and below this tunnel there is an adit about 100 feet in length. At a higher elevation on the mountain, an incline shaft was sunk on the vein to a depth of 300 feet. A considerable amount of ore was stoped from shaft workings and some ore has been stoped above the main tunnel level. The vein is oxidized gold quartz. The gold is found evenly distributed and is mostly free. Idle.

Bibl: State Mineralogist's Reports XII, p. 183; XIII, p. 230.



Sierra Vista Mine, Benton, Mono County.

Serita Mine. It is situated in Sec. 21, T. 6 N., R. 26 E., M. D. B. and M., and one-half of a mile west of the Pittsburg-Liberty Mine, and 12 miles northeast of Bridgeport, in the Masonic Mining District. Elevation 8000 feet. Owners, F. W. Stall and George C. Stall, of Masonic.

The development consists of a vertical shaft 220 feet deep and two crosscuts on the 100-foot level, one driven north 100 feet, the other south 85 feet. The orebody developed is from 4 to 10 feet wide and it is stated that the value in free gold ranges from \$3 to \$40 per ton. Idle.

Bibl: State Mineralogist's Report, p. 162.

Sierra Vista Mine. It is situated in the Chidago Mining District, in T. 3 S., R. 31 E., M. D. B. and M., on the west slope of the Benton Range of mountains, 11 miles southwest of Benton. Elevation 7300 feet. Owner, *Sierra Vista Mining Company*. H. M. Warren, president; R. I. Lamothe, secretary, Los Angeles. The property has recently been taken over under option by the *Universal Ore Milling and Mining*

Company, of Reno, Nevada. Dr. E. W. Ames, president, and W. B. Ames, general manager. This company plans the installation of a fifty-ton mill for treatment of the Sierra Vista ores, also to be used for custom mill on the ores of the district. The Sierra Vista Mining Company operated the property in 1926, but operations were suspended in the early part of 1927, due to the destruction of the company's 25-ton mill by fire.

There are three parallel veins on the property that strike N. 10° W. to N. 45° W. and dip southwest 40°. These veins vary in width from 2 to 8 feet. The formation is rhyolite and metamorphic limestone, with diorite intrusions. The Sierra Vista or West vein is the only vein that has been developed to any extent. This vein occurs on contact of metamorphic limestone and a rhyolitic porphyry, the former being the hanging wall of the vein and the latter the footwall. This vein strikes N. 10° W., dips 40° west and is from 2 to 4 feet wide. It has been developed by three tunnels. The main, or lower tunnel, has been driven east as a crosscut 500 feet. At 300 feet from the portal, the vein was cut and drifted on 150 feet north and 180 feet south. The vein has been stoped to the surface in the south drift for a length of 150 feet. In the north drift, a number of raises have been put up on ore.

The vein material is quartz-porphyry, with iron oxide streaks running through. The ore is free-milling, and is said to carry from \$6 to \$20 per ton. When the mill was under operation, the heads carried 0.72 ozs. in gold, 1.88 ozs. in silver, with 0.5 to 3% lead.

At 50 feet in elevation above this tunnel, there is a crosscut tunnel driven east 100 feet to the vein, with a drift north on the vein 200 feet.

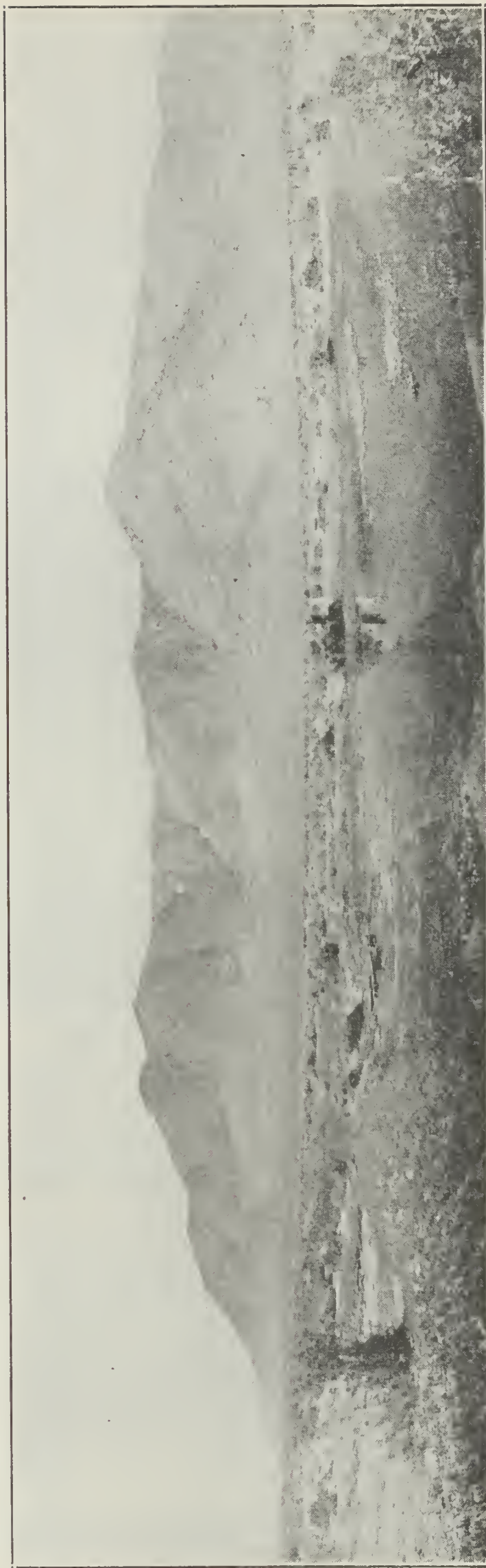
The upper tunnel is 50 feet above these workings and has been driven east 60 feet to the vein, with drifts north and south on the vein for a total distance of 100 feet. At an elevation of 7600 feet is what is known as the Pink Monster vein, which occurs in rhyolite and strikes northwest. This vein is about 8 feet wide. It has been developed in a gulch to the north by a tunnel 200 feet in length.

Equipment consists of 75-h.p. Semi-Diesel Y type Fairbanks-Morse gas engine; Reliable ball mill, capacity 25 tons. Two men employed.

Standard Mine. It is located at Bodie, and has been the most productive mine of the district. Owner, *Standard Consolidated Mining Company*. J. S. Cain, of Bodie, California.

The holdings of the company comprise about 200 acres. Besides the original Standard Claims, the following old companies were absorbed in 1895: Bodie, Bulwer, Mono and Summit, and the Bodie tunnel was purchased in 1901, the company owning practically all the land between the New Bodie and the Southern Consolidated.

The property was an active producer from 1877 to 1914, the production amounting to \$18,202,856, during which period the company paid out \$5,264,407 in dividends. There is no record of production from 1860 (when the Bodie Mining District was organized) to 1877. The principal development on the property was carried on through the Lent and Standard shafts, these shafts being 1200 feet deep. The



Blind Springs Hill, Benton, Mono County. Photo by Chas. A. Palmer.

property has been worked off and on by leasers since active development operations were suspended about 1917. Idle.

Bibl: State Mineralogist's Reports VIII, p. 385; XII, p. 183; XIII, p. 231; XV, pp. 150-158. Director of U. S. Mint, 1883, pp. 173-175.

Success Mine. It is situated in the Masonic Mining District, one mile south of the Chemung Mine, 9 miles northeast of Bridgeport. This property consists of two claims. Owners, John H. Hayes and C. C. Hayes, of Bridgeport. Under bond and lease to L. W. Dye, of Masonic, California.

The vein strikes northeast and dips to the east. The country rock is andesite. The vein has a width of 3 feet and is said to carry \$11 per ton in gold. Idle.

Bibl: State Mineralogist's Report XVIII, p. 416.

LEAD, SILVER AND ZINC.

The earliest mining in Mono County was that of silver ores in the Benton District, situated in the southeastern portion of the county.

The discovery of silver ore on the Cornucopia, Diana and Comanche veins on Blind Springs Hill, in 1862, was followed by a period of activity in production of silver from the Benton District, dating from 1862 to 1889. The total value of the production from the mines of the Benton District during this period was \$4,215,869. The other productive mining districts in the neighborhood of Benton were known as the Indian, Clover Patch and Chidago districts, about 8 to 12 miles southwest of Benton.

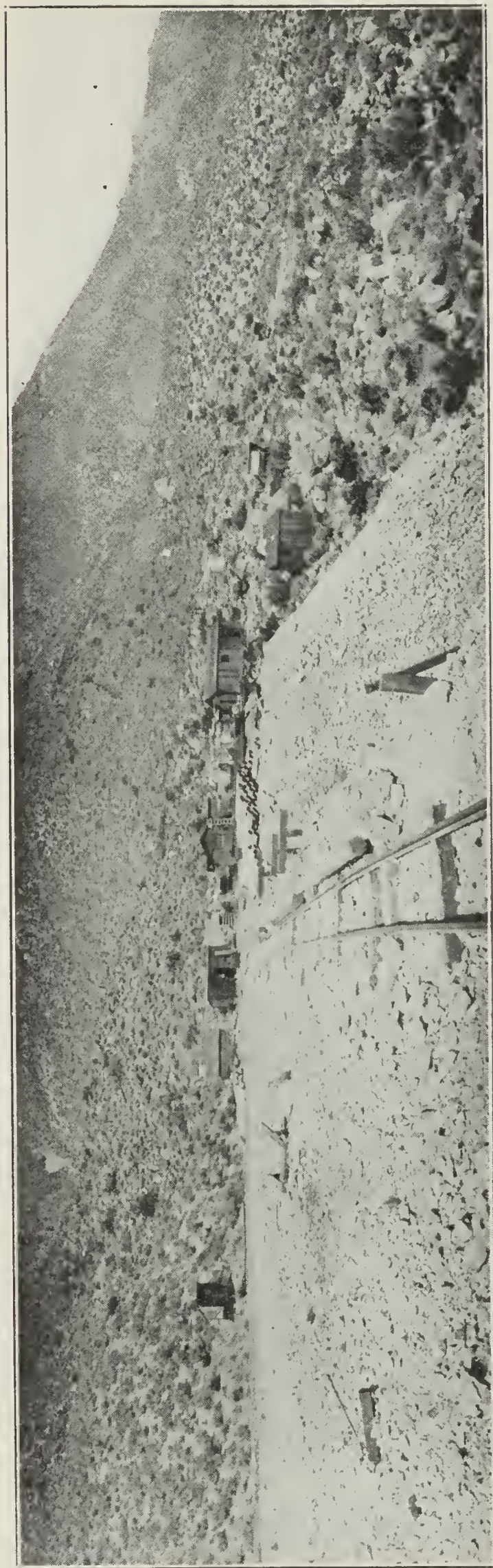
Lead occurs associated with the silver ores of these districts in the form of cerussite and galena.

More than one-half of the output of Blind Springs Hill, namely, \$2,200,000, was produced by three mines, the Comanche, Diana-Kerrick and Cornucopia. The other important productive silver district is known as the Patterson District, situated north of Bridgeport on the eastern slope of Sweetwater Mountains. The most productive mines were the Kentuck and Silverado.

The ores of the Blind Springs Hill District are complex associations of antimonial ores of copper, lead and silver, with small amounts of gold. The minerals in the ores are pyrite, chalcopyrite, bornite, tetrahedrite, sphalerite, galena, argentite, pyrargyrite, stephanite, kerargyrite, native silver, partzite, anglesite and cerussite. The ore minerals found in the lodes of the Patterson District are argentite, kerargyrite, pyrite and small amounts of native gold, associated with magnetite and iron oxides.

Silver also occurs associated with the gold ores of the Bodie and Mammoth districts in appreciable amounts. Deposits of lead-zinc ores occur in the narrow belts of crystalline limestone on the western slope of the Sierra, the principal occurrences being in the vicinity of Gull, June and Virginia lakes.

The most noteworthy mining development in progress in the county in recent years is being done by the *Comanche Mining and Reduction Company*, of Los Angeles. At an elevation of 5400 feet, on the east



Portal of crosscut tunnel. Comanche Mining and Reduction Co., Benton, Mono County. Photo by Chas. A. Palmer.

slope of Blind Springs Hill, a crosscut tunnel is being driven east to cut the Cornucopia, Diana-Kerrick and Comanche lodes. This tunnel will intersect these veins at a vertical depth below the outcrop of 1200 feet. The other important development work is on the Silverado Mine, in the Patterson Mining District, by the *Mono Mining Company*, of Chicago, Illinois. During the past year this company has spent a large amount of money in equipping the property with a power plant and the installation of a tramline from the mine to its new 100-ton cyanide plant.

Mines.

Banner Mine. (Gold-Silver.) It is situated 12 miles southwest of Benton, in the Chidago Mining District, and is now located as *Old Glory Group of Mines*. Holdings comprise 19 claims. Elevation 8000 feet. Owner, *Universal Ore Milling and Mining Company*, of Reno, Nevada.

The property was operated from 1870 until 1884. A small mill was built at Banner Springs and operated until 1884. The Banner lode strikes N. 40° W. and dips 15° southwest in granite. The vein was worked by several small incline shafts to a depth of about 150 feet, on the slope of the vein. Workings caved.

It is reported the Banner lode carried a notable content in gold, and it is reported that the bullion produced was about 700 fine in gold and 300 fine in silver. The present owner plans to do some development work on the property this year. Idle.

Comanche Mining and Reduction Company. Charles H. Palmer, president; C. H. Weaver, secretary; D. C. Palmer, superintendent. Offices, California Building, Los Angeles.

This company during the past six years has acquired all the property of the Blind Springs Mining Company, on Blind Springs Hill, which is situated 4 miles southeast of Benton. The holdings of the company comprise the Boraska, Comanche, Cornucopia, Kerrick-Diana and Hudson Group of Claims, consisting of 36 patented claims and 12 locations, amounting to 1660 acres, also 240 acres of patented land in Benton Valley, east of Blind Springs Hill, where the camp is located.

For the past six years this company has carried on active development work on the Comanche and Kerrick mines and is at present driving a 7' by 9' crosscut tunnel from the east side of Blind Springs which will intersect the productive lodes of the hill at a vertical depth of 1000 to 1200 feet.

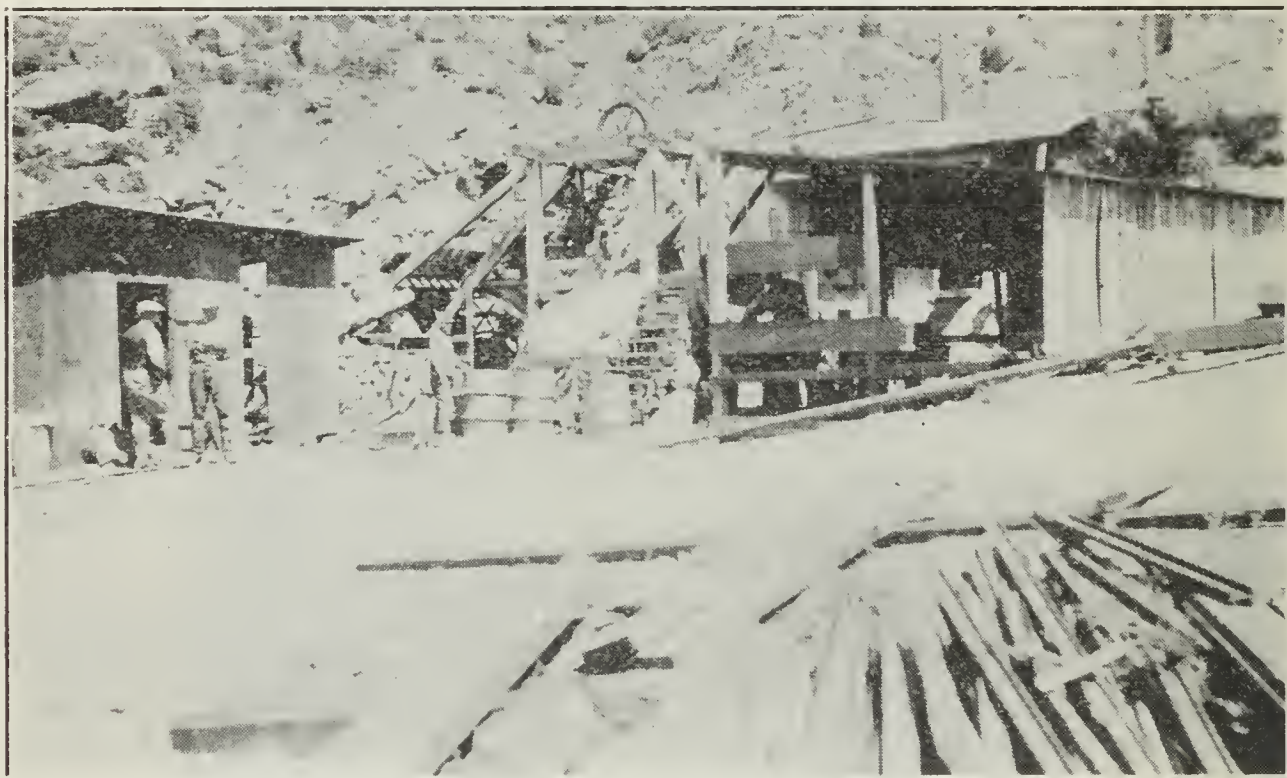
Blind Springs Hill is six miles in length. The mineral-bearing zone is from 2 to 3 miles in length from north to south and about 1½ miles in width from east to west. The formation of the hill is a hornblende granite. The veins or lodes are a series of parallel fault fractures which strike N. 10° W. to N. 20° W., with varying dips to the east from 45° to 82°.

The principal developed mines are the Diana-Kerrick, which has 4700 feet on the Diana-Kerrick Vein. This, with the Comanche vein system, constitutes the most westerly group of mines. The next easterly group of veins is the Anderson, Cornucopia, Lyford and Borasca. All the

veins, with the exception of the Comanche, dip from 30° to 45° to the east.

The Comanche Vein dips 82° east, having a width of from 7 to 8 feet. This vein has been worked through the Comanche Shaft to a depth of 750 feet and has been the most productive vein on Blind Springs Hill, having a reported production of \$1,000,000.

The present development work is confined to the Kerrick Shaft on the Diana-Kerrick Vein. The Diana Shaft is located 1500 feet south of the Kerrick Shaft. This shaft was sunk on the vein to a depth of 800 feet, and the vein stoped south to the Kerrick end line from the 800-foot level, a distance of 900 feet. The elevation of the Diana Shaft is 6800 feet. The Diana-Kerrick Vein strikes N. 10° W., and has an average dip of 47° to the east. The width of the vein varies from 18 inches to 4 feet. The orebodies occur as irregular lenses of antimonial copper-lead-silver ore carrying from 20 to 150 ounces in silver per ton, with



Kerrick shaft. Comanche Mining and Reduction Company, Benton, California.

from 20¢ to \$2 per ton in gold. At an elevation of 6600 feet, the Kerrick Shaft was sunk on the vein by former operators to the 650-foot level, where it was cut off by a fault which strikes N. 50° W., and dips 85° south. The vein was stoped both north and south of shaft to the surface from this level and it is reported was worked as far south as the Diana-Kerrick end line. The production of ore from the Diana-Kerrick mines is stated to have been about \$900,000.

The Kerrick Shaft has been sunk by this company from the 650-foot level to the 950-foot level, the shaft being in the hanging wall of the vein to the 750-foot level where the vein was encountered. From this point, the shaft is on the vein to the 950-foot level. The vein was step-faulted a distance of 30 feet. On the 850-foot level the vein has been drifted on 215 feet to the south and 175 feet to the north. On the east slope of Blind Springs Hill, at an elevation of 5400 feet, a 7' by 9' crosscut tunnel has been driven S. 49° W., 3500 feet. At this point the course of the tunnel turns due west for 300 feet and it is stated that the tunnel will intersect the Diana-Kerrick Vein at 4250 feet from the

portal, at a point 300 feet south of the Kerrick incline shaft. This tunnel level gives a 1200-foot vertical depth below the outcrop of the Diana-Kerrick Vein.

Equipment at the Kerrick Shaft consists of a 300-cu. ft. Ingersoll-Rand compressor and a 25-h.p. single drum gasoline-driven hoist.

At the main tunnel level the equipment consists of two (14" by 9½" by 14") Chicago pneumatic compressors, Sullivan drill sharpener, No. 8 Buffalo blower, driven by a 15-h.p. Fairbanks-Morse gas engine, and a blacksmith shop. Twenty-five men are employed.

Bibl: State Mineralogist's Report VIII, p. 376.

Cooney Zinc Mine. (Lead-Zinc.) It comprises 14 claims, located 5 miles southwest of Virginia Lakes Service Station, and about 14 miles south of Bridgeport. Elevation 9400 feet. Owners, A. W. Ahrens, Mrs. Bertha Hall and J. Cooney, of Bishop, California. Under option to Fred Knapton, J. Edward Rose and C. N. Rose, of Bishop, California.

The surface croppings are heavily iron-stained and the minerals contained are hornblende, pyroxene, epidote and garnet. These croppings occur in limestone and strike northwest. The outcrop is several hundred feet wide. A tunnel has been driven 120 feet southwest under this outcrop. At 30 feet from the portal, a lead-zinc sulphide orebody 40 feet wide was cut and samples taken over this 40-foot area are reported to carry 18% zinc and 10% lead, with 4 to 6 ozs. in silver per ton. The ore is sphalerite and galena, very closely associated.

At a higher elevation a shaft has been sunk in the center of the outcrop to a depth of 25 feet. At 10 feet below the collar of the shaft, lead-zinc sulphide ore was encountered. The orebody is a typical replacement deposit in limestone and from the extent of the surface croppings, the possibilities appear favorable for the development of a large body of ore. Idle.

Independence Mine. (Silver.) It comprises three claims situated 10 miles southwest of Benton, on the east slope of the Benton Range of mountains. Elevation 5750 feet. Owner, Joe Main, of Benton, California.

A massive outcrop of iron-stained quartz occurs in limestone. The vein strikes N. 30° W. and dips 40° east. A tunnel has been driven east 75 feet about 50 feet below the outcrop and a drift run south on the vein a distance of 90 feet. The vein in this drift is 4 feet wide. To the east of this outcrop a shaft has been sunk on a parallel fissure to a depth of 150 feet. North of these workings, the vein has been exposed by opencuts for several hundred feet. The ore carries values in silver with a small percentage of lead. Idle.

Huebner Group of Mines. (Lead-Silver.) It comprises a group of six claims situated in the Chidago Mining District, in the Benton Range of mountains, 12 miles southwest of Benton. Elevation 6800 feet. Owner, Julius Huebner, of Bishop, California.

Two parallel veins occur in granite, strike N. 10° E., and dip 70° east. Widths vary from 2 to 4 feet. The vein quartz is mineralized with pyrite, marcasite, galena and iron oxide. The principal values are in lead and silver, with \$2 to \$5 per ton in gold.

The main development has been on the east vein, on which an incline shaft has been sunk to a depth of 125 feet.

Equipment consists of a 6-h.p. Fairbanks-Morse hoist. Idle.

King Group of Mines. (Lead-Silver.) It comprises a group of six claims, situated in the Chidago Mining District, 10 miles southwest of Benton, in the Benton Range of mountains. Elevation 7450 feet. Owner, John King, of Benton, California.

A series of parallel veins occurs in the granite to the east of a rhyolite dike. The veins strike N. 30° E. and dip 50° west. The widths vary from 2 to 4 feet.

The principal amount of development is on one of the easterly veins. At an elevation of 7450 feet an incline shaft has been sunk on the vein to a depth of 100 feet and the vein has been stoped from the 50-foot level to the surface north and south of the shaft. About 300 feet south of this shaft and 100 feet in elevation below it, a crosscut tunnel has been driven 200 feet southwest to the vein, with drifts north and south on the vein. The vein quartz is mineralized with pyrite, marcasite and galena. The principal values in the ore are gold and silver, and occasional bunches of pure galena occur in the vein. One man is employed.

Lemont Group of Claims. (Lead-Zinc.) This group comprises 32 claims, located in Sec. 15, T. 2 S., R. 26 E., M. D. B. and M., on the ridge north of Gull Lake and 62 miles northwest of Laws, a station on the Southern Pacific Railroad. Elevation 7500 to 8000 feet. Owners, L. R. Montegue, F. C. Parmalee, C. W. Van Loon and H. A. Van Loon, of Bishop, California.

Lead-zinc sulphide ore occurs in a belt of metamorphic, crystalline limestone. This belt is about one mile in width with a general north-westerly course. The main ore occurrence is found along fissures in the limestone and along the bedding planes. The principal metamorphic minerals are hornblende, pyroxene, olivine, epidote and garnet, which have been replaced along the fissures by sphalerite and galena. In a small opencut there is exposed 3 feet of lead-zinc sulphide that occurs along a N. 40° W. fissure. It is stated that samples taken from this point carried 20% lead and 17% zinc, with 5 ozs. in silver per ton. At a higher elevation, a short tunnel has exposed 4 feet of lead-zinc sulphide ore along a N. 40° W. fissure. About 300 feet northwesterly from first opencut, galena and sphalerite are disseminated in the metamorphic limestone over an area 200 feet in width and 400 feet in length. On the west end of this group of claims, along the transmission line of the Southern Sierras Power Company, an opencut exposes 12 feet of limestone mineralized with sphalerite. A general sample taken over 12 feet is stated to carry 10% zinc. A general sample taken from ore extracted from the tunnel and lower opencut carried 20.7% lead, 13.9% zinc and 4 ozs. in silver per ton. Several men are employed on development work.

Lone Star Mine. (Lead-Silver.) It comprises seven claims known as the St. Ives Group, situated in the Chidago Mining District, 12 miles southwest of Benton. Elevation 7100 feet. Owner, *Lone Star Mining Company*, Reno, Nevada. Jacob H. Walker, president; S. J. Kistler, of Allentown, Pa., secretary; and G. B. Hartley, superintendent.

The vein strikes N. 15° W. and dips 80° west in rhyolite. Vein quartz is mineralized with pyrite, galena and marcasite, carrying values in silver and gold. The width of the vein varies from 18 inches to 3 feet.

Development consists of a two-compartment vertical shaft to a depth of 125 feet, then sunk on an incline of 80° for a distance of 185 feet. The vein has been drifted on the 125, 245 and 300-foot levels. On the 300-foot level, the vein has been drifted on 250 feet north and south of the shaft. There is also a crosscut east 770 feet. From the 125-foot level to the surface, a shoot of lead-silver ore has been developed 90 feet long with an average width of 3 feet. It is said that the average value of the shoot of ore is 17% lead, 26 ozs. silver per ton and \$10 to \$20 per ton in gold. From the 300-foot level to the 45-foot level, there is reported to be 15,000 tons of ore developed that will have an average value of \$12 per ton.

Equipment consists of 40 h.p. Fairbanks-Morse single drum hoist; 250-cu. ft. Chicago pneumatic compressor. The company is planning to install a 50-ton mill for the treatment of the ore developed. Five men are employed on development work.

Lyford Mine. (Lead-Silver.) It is situated on the east slope of Blind Springs Hill, 4 miles east of Benton, and adjoins the Barasca group on the south. Elevation 6400 feet. Holdings comprise five claims known as East Side, East Side No. 1, Valley View, Grand View and Buena Vista. Owner, W. H. Davis, of Benton, California.

The Lyford vein strikes N. 15° W. and dips 20° to 35° east. Width of vein varies from 12 inches to 3 feet. The formation is hornblende-granite. The orebody has been developed by a number of tunnels driven at different elevations. The main tunnel is 400 feet in length, with two other shorter tunnels above from 100 to 250 feet in length. The Lyford Vein is faulted by a dike or a fault which strikes N. 45° W., and dips north. This fault is 50 feet wide, the filling being a breccia, with nearly white clay casings, showing slickenside surfaces and striations. The ore cut in the tunnel is made up to the fault. At same elevation as this tunnel and to the north, a crosscut tunnel is driven west in the granite 500 feet. This tunnel was evidently driven west to cut the Diana-Kerrick Vein, but work was suspended before reaching this vein.

The orebodies worked occur in irregular lenses or masses, and these rich bunches are found on either the hanging wall or footwall of the vein. The minerals observed in the ore of the Lyford are similar in character to the ore of the other mines on Blind Springs Hill, being pyrargyrite, stephanite, magnetite and cerussite. The reported production of this mine is about \$200,000. One man is employed on development.

Bibl: State Mineralogist's Report VIII, p. 382.

Pat Reddy Mine. (Silver.) It comprises six claims situated on the east slope of Blind Springs Hill, 4 miles south of Benton, a station on the Southern Pacific Railroad. Elevation 5000 feet. Owner, *Benton Mining and Development Company*, of Los Angeles.

Two veins occur in hornblende granite, strike N. 10° W., and dip 40° to 45° east.

Development consists of a crosscut tunnel driven west 600 feet to develop the two veins that were worked in the early eighties. However, operations were suspended in 1924, without intersecting these veins. Idle.

Silverado Mine. (Silver.) This property comprises 15 claims known as the Silverado and Kentuck Group of Claims, situated in the Patterson Mining District, in Sec. 19, T. 7 N., R. 25 E., M. D. B. and M., 5 miles west of Sweetwater, Nevada. The mine is located on the eastern slope of Mount Patterson. Elevation 8600 feet. Owner, *Mono Mines Company*, of Nevada. Charles Gleixmer, president. Offices, 3123 North Clark street, Chicago, Illinois. Forest Mathoz, of Denver, consulting engineer; D. C. McKay, superintendent.

The Silverado Vein strikes N. 20° E., and dips 45° west, and has an average width of 4 feet. The footwall of the vein is andesite and the hanging wall is a rhyolitic porphyry. The vein material consists principally of quartz and shattered porphyry. The ore minerals found in the vein are pyrite, argentite, kerargyrite, associated with magnetite and other iron oxides. The silver minerals are intimately mingled with quartz and the richest ore has a dark, bluish color. The high grade ore occurs in the vein in lenticular masses. As a rule the high grade lenses of ore occur along the footwall of the vein. These rich lenses or masses are separated from one another at greater or less intervals by low grade ore, but the vein quartz in these intervals is never wholly barren. These rich masses occur where a series of parallel N. 55° W. faults cut the vein, but these faults do not displace the vein to any extent.

The mine is developed by four levels on the vein, known as the 500, 600, 700 and 800-foot levels that are 100 feet apart. The haulage tunnel is on the 600-foot level, which consists of a crosscut driven west 900 feet to the vein, with a drift south on the vein 1500 feet. The first ore shoot was encountered 350 feet south of this crosscut. The ore shoot worked was from 600 to 800 feet in length, with an average width of 4 feet and in places was worked for a width of 6 feet. A winze has been sunk from this level on the vein to a depth of 200 feet. At 100 feet below the collar of this winze, on the 500-foot level, the vein has been drifted on 700 feet. On the 700-foot level, which is 100 feet above the 600-foot level, the vein has been drifted on 1000 feet and the ore shoot developed on this level is 600 feet in length. On the 800-foot level the vein has been drifted on 600 feet.

All present development and stoping operations are confined to the levels above the 500-foot level. The high grade masses are being mined and sorted underground for shipment. The second grade ore is being stored in stopes for treatment in the mill. This latter ore is stated to have an average value of \$10 per ton in silver. The high grade ore being shipped is said to carry from \$200 to \$600 per ton. This ore is now being shipped in ten-ton lots to the Humboldt smelter.

The Kentuck Mine, which is said to be on the same vein as the Silverado Mine, is 4480 feet south of the Silverado Mine workings, and 1400 feet in elevation above the 600-foot level.

The Kentuck Mine was opened up by two adit levels on the vein to a depth of 300 feet below the outcrop, and a winze from the lower tunnel level explored the vein to a depth of 100 feet. This property has not been worked since 1884 and its production is reported to be about \$500,000.

Equipment: Electric power is secured from the company's hydro-electric power plant located on Green Creek, 9 miles south of Bridge-

port. The transmission line from power plant to mine is 32 miles in length. Air for mining operations is furnished by a Nordberg compressor, the compressor plant being located above the mill. There is also a 500-cu. ft. Sullivan compressor driven by 100-h.p. motor at the mine. Ore from mine is transported to crushing plant a distance of 1500 feet. The crushed ore is transported over an aerial bucket tram line 2500 feet in length to a 100-ton cyanide plant. The mill was idle at the time the property was visited, but the company plans to place the mill under operation by the first of October. Twenty men are employed.

Bibl: State Mineralogist's Reports VIII, pp. 359-361; XV, pp. 165-166. Report of Director U. S. Mint, 1883.

Silver Reef Mine. (Lead-Silver.) It comprises a group of 4 claims, situated on the east slope of the Benton Mountains and 11 miles southwest of Benton. Owner, Joe Main, of Benton, California. Elevation 5900 feet.

Two parallel veins occur in limestone that strike N. 20° W., and dip 60° west. Width of veins varies from 12 inches to 4 feet. The belt of limestone in which these veins occur is about one mile in width. In the vicinity of the veins there is a diorite intrusion that strikes N. 40° W.

Developments consist of 8 shafts sunk on the most easterly vein to depths of 50 to 200 feet. These shafts are about 100 feet apart, and all have produced some ore. Shipments of ore made from the property are reported to carry from \$60 to \$200 per ton in lead and silver.

The minerals contained in the vein quartz are argentite, with bromides and chlorides of silver, galena and cerussite. The Silver Reef Shaft is 125 feet deep sunk on the vein, with drifts south on the fissure at 90 and 125 feet. About 100 feet south of this shaft, there is a shaft 90 feet deep which is connected on the 90-foot level. To the south of the Silver Reef shaft, a distance of approximately 325 feet, there is another shaft on the vein to a depth of 300 feet. One man is employed.

Tower Mine. It comprises two patented claims, situated in the Indian Mining District, 8 miles southwest of Benton, on the west slope of the Benton Range of mountains. Elevation 6400 feet. Owner, W. W. Watterson, Bishop, California.

The vein occurs in granite and strikes N. 10° E., and dips 80° west. The width varies from 2 to 4 feet. The ore occurs in the vein as irregular bunches or kidneys of rich argentiferous pyrite in quartz, the associated minerals being chiefly sphalerite, pyrite, galena, with pyrrargyrite and other antimonial silver ores.

Development consists of two shafts, one sunk on the vein to a depth of 200 feet, and about 300 feet west a vertical shaft sunk in the footwall granite to a depth of 300 feet. The mine is reported to have had a production of \$150,000. Idle.

Wild Rose Mine. (Lead-Gold-Silver.) The property comprises five claims, situated in Wildrose Canyon, in the Chidago Mining District, 6 miles southwest of Benton, California. Elevation 7500 feet. Owner, C. W. Stone, Florida; W. N. Davis, agent, Benton. Under lease to John Zakeila and associates, of Benton.

The Wild Rose Vein occurs in granite and strikes north with a dip of 70° to the west. The vein has a width of 4 feet. The vein quartz is

mineralized with pyrite, galena, marcasite and carries values in gold and silver. The silver minerals contained are argentite and pyrargyrite.

Development consists of a crosscut tunnel driven east 200 feet to the vein, with drifts north and south on the vein. It is reported that the vein was drifted on a distance of 500 feet on this level. The vein has been stoped to the surface. At 30 feet north of the crosscut, a winze is being sunk on the vein. The property has a rated production of \$100,000. Two men are employed.

NONMETALLIC MINERALS.

Mono County has a great variety of commercial minerals and contains deposits of both industrial and structural materials, whose development at present is held back by lack of transportation. The highly mineralized belt which runs through the county contains deposits of andalusite, barytes, clay, limestone, mineral water, pumice, salt, soda, silica, travertine and tuff.

ANDALUSITE.

Sillimanite and andalusite are both aluminum silicates (Al_2SiO_5) having the same composition and formula, but with slightly different physical characteristics. Though both crystallize in the orthorhombic system, their crystal habits are different, andalusite being usually in coarse, prismatic forms, the prisms nearly square in shape; also occurs massive, imperfectly columnar, and sometimes radiated and granular. Sillimanite commonly occurs in long, slender crystals, not distinctly terminated; prismatic faces, striated and rounded; often in close parallel groups, passing into fibrous and columnar massive forms, sometimes radiating. Colors are similar. Hardness, andalusite 7.5; sillimanite 6.7. Andalusite is slightly lighter in specific gravity.

Mono County has the distinction of having the only commercial deposit of andalusite so far discovered in the United States. A massive deposit of andalusite occurs in the White Mountains of the Inyo Range, and is being mined by the Champion Porcelain Company, of Detroit, Michigan.

Champion Porcelain Company's Andalusite Deposit. The deposit is located on the north side of Dry Creek Canyon, on the northwest slope of White Mountains, 7 miles east of Hammil, a station on the California and Nevada Railroad. Elevation 8600 to 10,000 feet. Holdings comprise four claims. Owner, Champion Porcelain Company, Detroit, Michigan. Dr. J. A. Jeffrey, president; B. A. Jeffrey, secretary; C. E. Julian, superintendent.

The country rock in the vicinity of the deposit consists of slates, schist, and quartzite. There are two prominent dikes, more or less parallel, which have a general northerly strike. The lower or most westerly dike is about 200 feet in width. This dike carries andalusite but it is too low grade to mine. The easterly dike, which occurs on the contact of diorite and granite, at a higher elevation, carries a higher content of andalusite. This dike is over 200 feet wide and forms a bold outcrop for a distance of over 500 feet. The andalusite occurs along the east face of this quartz or quartzite dike. The andalusite occurs as irregular stringers and lenses in the dike. The ore mined carries 75% andalusite.

The other minerals contained are pyrophyllite, muscovite, lazurite, corundum, rulite and lazulite.

Mining operations were started on this deposit in 1921, and it has been a steady producer to date.

Development consists of a tunnel driven west nearly through the dike, with laterals driven north and south along ore showings in the dike.

The ore is mined by open stope and pillar method. The ore is broken and sorted to a size of 4 to 6 inches in diameter. It is sacked to 100 pounds for packing by pack train to loading camp, a distance of 4 miles, then hauled by truck to Shealy Siding on the railroad for shipment to Detroit, Michigan, where it is utilized in the manufacture of porcelain for automobile spark plugs and for other high-tension electric insulators. The production amounts to about 150 tons per month.

Equipment consists of a compressor; air drills; and houses for employes. Fifteen men are employed.

Bibl: State Mineralogist's Report XX, pp. 149-154; Bull. 94, pp. 106-108.

Taylor Andalusite Deposit. It comprises six claims located north of the Champion Porcelain Company's property. Elevation 10,000 feet. Owner, A. Taylor, Benton, California.

The deposit occurs along the same dike that is being worked by the Champion Porcelain Company. Andalusite occurs as irregular stringers and lenses in the dike.

Development consists of a number of shallow opencuts and short tunnels. Idle.

LIMESTONE.

In the southeastern end of the county there is a belt of Cambrian limestone that occurs on the west slope of the White Mountains. This belt of limestone runs in a northerly direction from the Inyo County line to the Nevada state line. The belt is 25 miles in length and about 3 to 6 miles wide.

MINERAL SPRINGS.

There are a number of mineral springs in Mono County, the different hot springs in the northern and eastern portion being of considerable geologic interest. Some of these springs would become popular resorts were they accessible to a larger population.

Artesian Springs are located at Oasis, 30 miles northeast of Alvord, a station on the California and Nevada Railroad. Elevation 5100 feet. Water used for irrigation. Owner, J. H. Forman, of Oasis, California.

Banner Spring. It is situated west of Benton, in the Inyo National Forest. Elevation 7300 feet. Water used for watering sheep.

Benton Hot Spring. It is situated 300 yards northwest of Benton post office. Elevation 5640 feet. Owner, W. H. Davis, of Benton, California.

The spring is approximately 10 feet in diameter, in which the water has a temperature of 135° F. It has furnished a supply of water for the town for domestic and irrigation uses since 1862. Its discharge is approximately 400 gallons per minute. Quoting from a laboratory report made of the water by Smith-Emery Company, of Los Angeles:

“The water is unique because of the absence of lime and magnesium salts, as well as an exceptionally low content of other mineral constituents. Medical authorities state that water free from lime and magnesium salts is beneficial in the treatment of certain diseases, such as gall stones, kidney stones and diabetes.”

Bibl: U. S. G. S. Water Supply Paper 338, p. 136.

Bertrand Ranch Springs are situated 6 miles east of north from Benton. Elevation 5000 feet. Temperature of water 70° F. Flow 100 gals. per minute. Used for irrigation.

Black Lake Springs are situated 2 miles northwest of Benton. Elevation 6425 feet. Used for irrigation. Owner, Peter Gilholt, of Benton, California.

Buckeye Hot Spring is situated about 5½ miles southwest of Bridgeport, on the north bank of Buckeye Creek. Elevation 6950 feet. The water issues with a temperature of 140° F., and flows at about 25 gallons per minute. The water contains notable amounts of lime and a high amount of iron in solution. Used for bathing.

Bibl: U. S. G. S. Water Supply Paper 338, pp. 132–133.

Casa Diablo Hot Springs are situated on lava slopes bordering Hot Creek, north of the main highway about 45 miles northwest of Bishop. Elevation 7350 feet.

In a small depression north of the highway, small amounts of vapor rise from a half dozen small pits. On the north rim of the depression, a small pit in the bank forms a ‘paint pot’ in which pink mud is kept in motion by bubbles of steam. Temperatures range from 115° to 198° F.

Bibl: U. S. G. S. Water Supply Paper 338, pp. 146–147.

Fales Hot Springs are situated 13 miles northwest of Bridgeport, on the road to Minden, Nevada. Elevation 7300 feet. Owner, Samuel Fales.

The hot water rises along the bed of a small creek which has been dammed to form a bathing pool. The temperature of the water issuing from the springs ranges from 129 to 141° F. It is reported to flow about 300 gallons per minute. Resort with hotel accommodations and cabins for camping parties.

Bibl: U. S. G. S. Water Supply Paper 338, p. 132.

Mono Basin Warm Springs are situated at the east edge of Mono Lake. Elevation 6425 feet.

Bibl: U. S. G. S. Water Supply Paper 338, pp. 145–146.

Moran Spring is situated 13 miles southwest of Benton. Elevation 7000 feet.

River Springs are situated 10 miles northwest of Benton. Elevation 6480 feet. Owner, A. Matlick, of Bishop. Water used for irrigation.

Travertine Springs. This group of springs is situated 1½ miles southeast of Bridgeport, on the hilly slopes of andesite lava, 200 to 300 feet above the valley. Here are located a number of prominent ridges

of banded onyx marble, 5 to 15 feet high and somewhat greater thickness. At two points near these ridges, small springs with temperature of 121 to 148° F. rise in pools about 3 to 10 feet in diameter. A third spring issues from a longitudinal crevice in the top of one of the ridges. Temperature is stated to be 148° F.

Bibl: U. S. G. S. Water Supply Paper 338, pp. 133-135.

Warner Hot Springs are situated one mile northeast of Casa Diablo Hot Springs and one-half mile northwest of the highway, 45 miles northwest of Bishop. Holdings comprise 6 claims, known as the Sulphate Group. Owner, P. A. Warner, Los Angeles. Elevation 7200 feet.

Two shafts were sunk to a depth of 10 feet. In the bottom of the shafts are vapor vents and some hot water. A number of hot springs are scattered over several acres of ground.

Whitmore Tub Springs are situated in Long Valley, 3 miles west of Owens River and about 7 miles southeast of Casa Diablo Springs. There are two oblong pools a few feet apart and 40 feet long in which warm water rises from which it flows to a shallow pond called Whitmore Tub. A new bathhouse has been built and the pools converted into a swimming tank.

Bibl: U. S. G. S. Water Supply Paper 338, pp. 147-148.

PUMICE AND VOLCANIC ASH.

There are extensive deposits of pumice that occur in the volcanic tableland on the west side of Hammil and Benton valleys. The principal deposits of this material extend from Benton south to the Inyo County line. Other deposits of importance occur on the west slope of the White Mountains, extending south from Sacramento Canyon to the Inyo County line. The material from Mono County is the volcanic ash or tuff variety and is employed in making soap and cleanser compounds.

California Quarries Pumice Deposit. It is situated 6 miles north of Laws on the west side of Hammil Valley. Holdings comprise 640 acres. Elevation 4400 feet. Owner, California Quarries Company, A. B. Rudock, president; Garnet C. Rainey, secretary; J. L. Hassett, superintendent. Offices, 1300 Quinby Bldg., Los Angeles.

The horizontal bed of white pumice is from 12 to 15 feet thick, with an overburden of red tuff from 25 to 75 feet in thickness.

Two quarries have been opened up on this bed of pumice. The method of working consists in stripping the overburden, then the pumice is transported by scrapers to an ore pocket above the mill. The material is white in color, and breaks up very fine. The lumps range from the size of a pea to that of a walnut. Material from the quarries goes to a 50-ton grinding and separating plant. The products produced are silica (crystal sand and pumice).

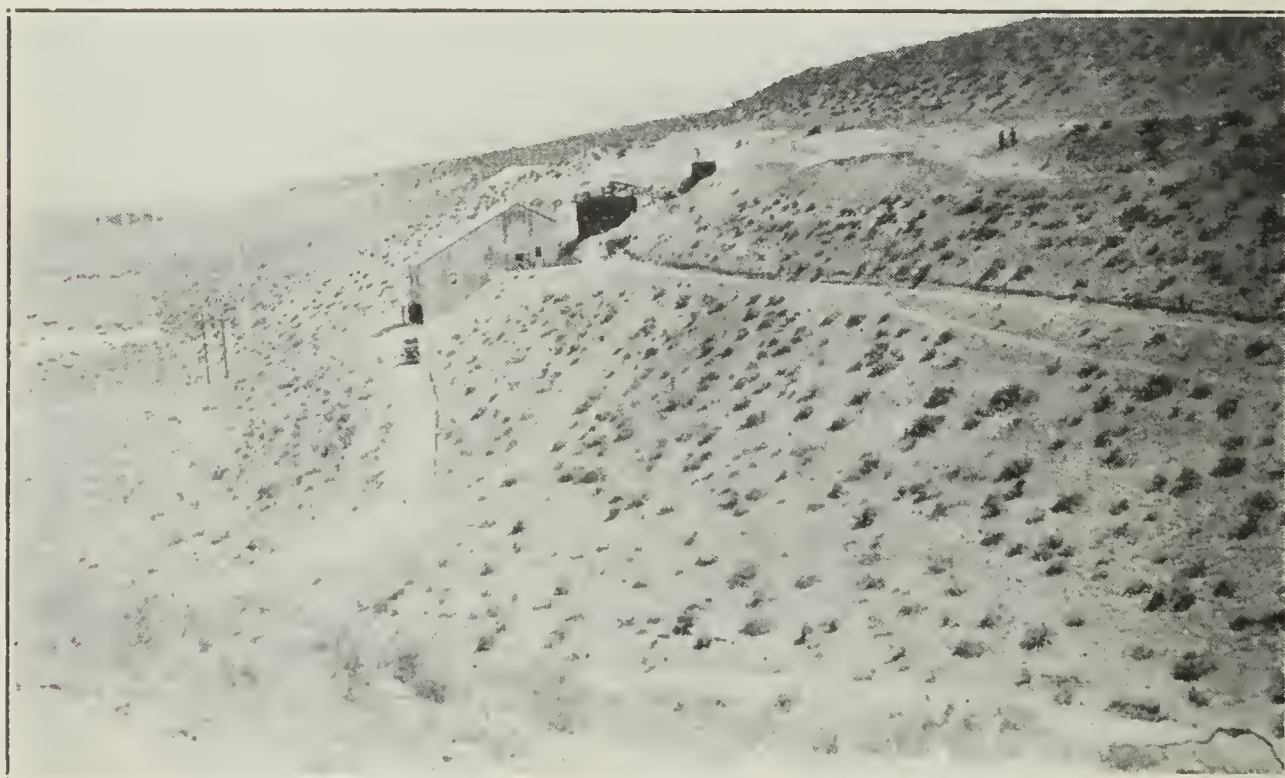
The material is used in making soap and cleanser compounds, also for stucco work, white cement and in acoustic plaster. Fifteen men are employed.

Blind Springs Hill Pumice Deposits. These deposits are situated on the east slope of Blind Springs Hill about 5½ miles south of Benton, a

station on the Southern Pacific Railroad. Elevation 5200 feet. Holdings comprise 16 claims. Owners, William Ray, Joe Moletesta, of Hawthorne, Nevada.

The occurrence on the east slope of Blind Springs Hill is one mile in length and about one-quarter of a mile in width. The bed of pumice is 20 feet thick, being overlain by red tuff from 5 to 25 feet thick. A number of tunnels and opencuts expose the bed of pumice for a distance of 1000 feet. The pumice is white in color and the sizes of the material range from pea size up to walnut size. Idle.

Sacramento Canyon Pumice Deposit. It comprises 40 acres situated on the west slope of the White Mountains north of Sacramento Canyon, 3 miles northeast of Chalfant, a siding on the Southern Pacific Railroad, and 11 miles north of Laws. Elevation 5300 feet. Owner, Joseph B. Smith, of Laws, California.



California Quarries Company's Pumice Deposit, Mono County.

The bed of pumice is exposed on the surface for a distance of 500 feet in length, and about 200 feet in width. The pumice is pure white in color and most of the material is quite fine, the largest size being about the size of a walnut. Idle.

Yellow Jacket Canyon Pumice Deposits. In the low, rounded hills on both sides of Yellow Jacket Canyon, to the south of Yellow Jacket Spring, are exposed extensive deposits of white pumice. The beds exposed in the canyon are from 30 to 50 feet thick, with practically no overburden.

These deposits are situated 7 miles south of Benton, and $3\frac{1}{2}$ miles west of Hammil, a station on the Southern Pacific Railroad. Elevation 5600 feet. Holdings comprise 640 acres, located in Sec. 8, T. 3 S., R. 3 E., M. D. B. and M. Owner, Joseph B. Smith, of Laws, California.

The pumice is pure white to gray in color. The material is quite fine, the largest size being about the size of a walnut. Idle.

SODA AND SALT.

The only soda produced in Mono County is derived from the waters of Lake Mono. The waters of this lake contain common salt, soda, borax and other soluble salts. The only production is a small amount of valuable medicinal salts obtained by evaporation of the water.

Lake Mono Salt Works. This plant is situated on the northeast shore of Lake Mono. Owner, Wallace D. McPherson, Mono Inn, Mono Lake postoffice.

The capacity of the plant is 250 pounds per 24 hours. The water from the lake is evaporated for the recovery of the salts which are sold for medicinal salts.

TRAVERTINE.

Bridgeport Travertine Deposits. These deposits are situated one mile southeast of the town of Bridgeport, on hilly slopes of andesite lava,



Travertine deposit, Bridgeport, Mono County.

200 to 300 feet above the valley. Owners, Chas. L. Hayes, of Bridgeport and Edward Dinneen, of Oakland, California. Holdings comprise 60 acres, which cover both springs and travertine deposits.

There are five prominent ridges of banded onyx marble, or travertine, from 6 to 15 feet high and of somewhat greater thickness that tend to radiate from a central point. These ridges are cut longitudinally by a vertical crevice. The travertine is banded and stained various shades of red and yellow. The material has a pleasing mottled effect, is sufficiently translucent to give depth to the coloring and takes a good polish. The deposit is 50 miles from the nearest railroad point.

Several quarries have been opened up on the deposit and a carload of the material shipped to the *Dinneen Marble Company*, of Oakland, in 1926.

Equipment consists of a derrick.

Bibl: State Mineralogist's Report XII, p. 640; XV, pp. 173, 174.
U. S. G. S. Water Supply Paper 338, pp. 132-136.



Travertine being deposited by mineral spring at Bridgeport, Mono County.
Photo by Walter W. Bradley.

TUFF.

Extensive deposits of tuff suitable for building material occur in the volcanic tableland that extends from the Inyo County line to Benton Hot Springs. South of the Mono County line in Round Valley, Inyo County, this material is being quarried by the Bly Stone Company, of Los Angeles.

The material in Mono County is being used locally by the ranchers in Hammil and Benton valleys in the construction of residences.

When quarried the material can be taken out in large blocks and can be sawed into dimensions required for buildings.

OIL FIELD DEVELOPMENT OPERATIONS.

By R. D. BUSH, State Oil and Gas Supervisor.

From July 3, 1927, to and including October 1, 1927, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
COLUSA COUNTY:					
The Numa Oil Co.-----	19	15	5	1	-----
FRESNO COUNTY:					
Premier Oil Co.-----	24	20	14	24	Coalinga
Standard Oil Co.-----	7	20	15	227	Coalinga
Superior Oil Co.-----	26	21	17	Hanson 1	-----
Superior Oil Co.-----	16	17	14	Lillis-Welch 1	-----
KERN COUNTY:					
Associated Oil Co.-----	23	28	27	1	Kern River
Associated Oil Co.-----	23	28	27	5	Kern River
Associated Oil Co.-----	23	28	27	25	Kern River
Associated Oil Co.-----	23	28	27	35	Kern River
Associated Oil Co.-----	23	28	27	45	Kern River
Associated Oil Co.-----	23	28	27	55	Kern River
Assoeiated Oil Co.-----	23	28	27	56	Kern River
California Petroleum Corp.-----	23	28	27	Lehmann 1	Kern River
C. C. M. O. Co.-----	23	28	27	7	Kern River
C. C. M. O. Co.-----	23	28	27	8	Kern River
C. C. M. O. Co.-----	23	28	27	9	Kern River
General Petroleum Corp.-----	14	28	27	14	Kern River
General Petroleum Corp.-----	14	28	27	15	Kern River
General Petroleum Corp.-----	14	28	27	28	Kern River
General Petroleum Corp.-----	26	28	27	Sill 2	Kern River
General Petroleum Corp.-----	26	28	27	Sill 13	Kern River
General Petroleum Corp.-----	14	28	27	Wetmore 13	Kern River
George F. Getty-----	14	28	27	Lehnhardt 17	Kern River
George F. Getty-----	14	28	27	Lehnhardt 18	Kern River
George F. Getty-----	14	28	27	Lehnhardt 19	Kern River
George F. Getty-----	14	28	27	Lehnhardt 23	Kern River
George F. Getty-----	14	28	27	Lehnhardt 24	Kern River
George F. Getty-----	14	28	27	Lehnhardt 25	Kern River
George F. Getty, Inc.-----	26	28	27	Grady 1	Kern River
George F. Getty, Inc.-----	22	28	27	Tegeler 23	Kern River
George F. Getty, Inc.-----	22	28	27	Tegeler 24	Kern River
George F. Getty, Inc.-----	22	28	27	Tegeler 25	Kern River
F. C. Grimes and Associates-----	14	28	28	Dorwart 1	Kern River
F. C. Grimes and Associates-----	14	28	28	Guerrier 1	Kern River
F. C. Grimes and Associates-----	14	28	28	Hartshorn 1	Kern River
Petroleum Securities Co.-----	22	28	27	5	Kern River
Petroleum Seeurities Co.-----	22	28	27	1-B	Kern River
The St. Helens Petroleum Co., Ltd.-----	26	28	27	1	Kern River
The St. Helens Petroleum Co., Ltd.-----	13	28	28	Kernco 1	Kern River
Standard Oil Co.-----	27	28	27	10	Kern River
Standard Oil Co.-----	15	28	27	11	Kern River
Standard Oil Co.-----	27	28	27	11	Kern River
Standard Oil Co.-----	15	28	27	12	Kern River
Standard Oil Co.-----	27	28	27	12	Kern River
Standard Oil Co.-----	15	28	27	13	Kern River
Standard Oil Co.-----	15	28	27	14	Kern River
Standard Oil Co.-----	15	28	27	15	Kern River
Standard Oil Co.-----	15	28	27	16	Kern River
Standard Oil Co.-----	34	28	27	Emma Kramer 1	Kern River
Wonder Co., Ltd.-----	23	28	27	12	Kern River
Wonder Co., Ltd.-----	23	28	27	13	Kern River
Cymric Oil Co.-----	26	29	21	5	McKittrick
Keefe-Morrison, Inc.-----	8	30	22	6	McKittrick
Keefe-Morrison, Inc.-----	8	30	22	6-A	McKittrick
North American Oil Cons.-----	32	31	24	12	Midway
North American Oil Cons.-----	30	31	24	44	Midway
Standard Oil Co.-----	29	31	24	44	Midway
Standard Oil Co.-----	7	32	24	235	Midway

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued.					
Victor Oil Co.....	35	32	23	7-A	Midway
Midland Oilfields Co., Ltd.....	6	27	28	D. G. Vedder 1	Mt. Poso
Shell Co.....	1	27	27	Glide 2	Mt. Poso
Superior Oil Co.....	13	27	28	Glide 1	Mt. Poso
Union Oil Co.....	10	11	23	Houchin 3	Sunset
J. F. Harrison & Co.....	36	29	20	2	Temblor
J. F. Harrison & Co.....	36	29	20	3	Temblor
Standard Oil Co.....	27	11	20	Kern Co.	
				Lease 2 30	Wheeler Ridge
General Petroleum Corp.....	5	30	29	Kerwin 1	
George F. Getty, Inc.....	22	29	29	Bill Beaizley 1	
L. & B. Producing & Drilling Co.....	19	28	29	Jewett 1	
Ed. McAdams, Trustee.....	26	29	23	G. & Y. 1	
North American Oil Cons.....	5	25	26	Wallace 1	
The Pacific Eastern Production Co.....	21	29	27	Fruitvale 1	
Shell Co.....	3	28	28	Glide 1	
KINGS COUNTY:					
General Petroleum Corp.....	4	24	19	Kettleman 1	
LOS ANGELES COUNTY:					
Union Oil Co.....	33	3	13	Callender 20	Dominguez
Brownmoor Oil Co.....	7	2	14	7	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 45	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 53	Inglewood
Standard Oil Co.....	17	2	14	Baldwin-	
				Cienega 54	Inglewood
Standard Oil Co.....	17	2	14	L. A. Invest. 1 54	Inglewood
Aeme Petroleum Corp.....	19	4	12	Damron 7	Long Beach
Delaney Petroleum Corp.....	29	4	12	14	Long Beach
Graham-Loftus Oil Co.....	19	4	12	Butler 1	Long Beach
George W. Johnson.....	29	4	12	Crest 3	Long Beach
A. S. Johnston Drilling Co.....	29	4	12	1	Long Beach
McKeon Drilling Co., Inc.....	19	4	12	Evans 1	Long Beach
J. E. O'Donnell.....	19	4	12	59	Long Beach
Pan-American Petroleum Co.....	19	4	12	Chainey 3	Long Beach
The Petroleum Co.....	24	4	13	Nutting-Lough 2	Long Beach
Richfield Oil Co.....	19	4	12	Bernstein 2-A	Long Beach
Richfield Oil Co.....	29	4	12	Freeman 2	Long Beach
Richfield Oil Co.....	19	4	12	Hass 14	Long Beach
Richfield Oil Co.....	19	4	12	Kelly 1	Long Beach
San Martinez Oil Co.....	29	4	12	Booth Comm. 8	Long Beach
Shell Co.....	29	4	12	Alamitos 24	Long Beach
Stevens Drilling Co.....	24	4	13	Steve 2	Long Beach
Standard Oil Co.....	6	2	11	Baldwin 71	Montebello
McCoy & Anderson.....	13	3	16	4	Newhall
Fred E. Cole.....	18	3	13	2	Rosecrans
Shell Co.....	6	3	11	Slusher 12	Santa Fe Springs
Standard Oil Co.....	5	3	11	So. Whittier	
				Comm. 20	Santa Fe Springs
Associated Oil Co.....	11	5	12	Hellman 17-A	Seal Beach
Associated Oil Co.....	11	5	12	Hellman 27	Seal Beach
General Petroleum Corp.....	3	5	12	Wasem 6-A	Seal Beach
Marland Oil Co.....	11	5	12	McGrath &	
				Selover 20	Seal Beach
Olympic Refining Co.....	3	5	12	12	Seal Beach
Standard Oil Co.....	3	5	12	San Gabriel 14-A	Seal Beach
C. C. M. O. Co.....	17	4	14	Del Amo 95	Torrance
C. C. M. O. Co.....	8	4	14	Del Amo 96	Torrance
C. C. M. O. Co.....	15	4	14	Torrance 71	Torrance
C. C. M. O. Co.....	15	4	14	Torrance 79	Torrance
Anchor Petroleum Co.....	19	2	10	1	
John B. Harding.....	28	7	11	La Loma 1	
Monterey Park Petroleum Corp.....	26	1	12	Browning 1	
J. E. O'Donnell.....	29	3	14	61	
San Clemente Oil Co.....	20	3	14	1	
White Behr Consolidated Oil Co.....	20	4	13	Watson 1	

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
MADERA COUNTY:					
Fort Wayne-Madera Syn.-----	22	10	17	1	-----
ORANGE COUNTY:					
Shell Co.-----	1	3	10	Fisher 7	Brea-Olinda
Shell Co.-----	2	3	10	Orange 14	Brea-Olinda
Shell Co.-----	2	3	10	Orange 16	Brea-Olinda
Chiksan Oil Co.-----	19	3	9	Mathis 2	Coyote Hills
Herndon Petroleum Corp.-----	19	3	9	Lemke 3	Coyote Hills
Herndon Petroleum Corp.-----	20	3	9	Queyrel 1	Coyote Hills
Petroleum Securities Co.-----	19	3	9	Wright 1	Coyote Hills
Union Oil Co.-----	33	3	13	Callender 21	Dominguez
B. H. R. Oil Co.-----	10	6	11	DuBois 1	Huntington Beach
Bell of Montebello Oil Co.-----	2	6	11	5-A	Huntington Beach
J. A. Brower-----	11	6	11	1	Huntington Beach
Allen Brown-----	10	6	11	Allen Brown 3	Huntington Beach
George E. Cloud-----	10	6	11	1	Huntington Beach
Harry B. Custer-----	34	5	11	2	Huntington Beach
Davis, Haines & Tompkins-----	10	6	11	1	Huntington Beach
Davis, Quine & Davis-----	10	6	11	1	Huntington Beach
J. F. Garliepp-----	10	6	11	Andrews 1	Huntington Beach
Globe Lease & Royalty Co.-----	27	5	11	3	Huntington Beach
Golden Rod Oil Co.-----	2	6	11	Golden Rod 3	Huntington Beach
H. & M. Oil Well-----	10	6	11	1	Huntington Beach
Hauser Petroleum Co.-----	10	6	11	1	Huntington Beach
James & Price-----	10	6	11	2	Huntington Beach
James & Price-----	10	6	11	3	Huntington Beach
S. W. Lea and L. E. Kesselman-----	10	6	11	H. B. 1	Huntington Beach
Lloyd & Reynolds-----	10	6	11	1	Huntington Beach
Loftin Oil Co.-----	10	6	11	2	Huntington Beach
C. B. Lones-----	10	6	11	1	Huntington Beach
Ben F. Mun-----	10	6	11	Mun 1	Huntington Beach
Ben F. Mun-----	10	6	11	Mun 2	Huntington Beach
J. E. O'Donnell-----	27	5	11	O'Donnell 60	Huntington Beach
Standard Oil Co.-----	4	6	11	Bolsa 31	Huntington Beach
Standard Oil Co.-----	10	6	11	P. E. 14	Huntington Beach
Standard Oil Co.-----	10	6	11	P. E. 15	Huntington Beach
Leo Stein-----	21	5	11	1	Huntington Beach
Frank Vessels-----	10	6	11	1	Huntington Beach
Warren and Macrate-----	10	6	11	2	Huntington Beach
Warren and Macrate-----	10	6	11	3	Huntington Beach
Sy Wicker-----	10	6	11	2	Huntington Beach
World Petroleum Corp.-----	10	6	11	7	Huntington Beach
World Petroleum Corp.-----	10	6	11	8	Huntington Beach
Young-Lundberg-----	10	6	11	Y. L. 1	Huntington Beach
Associated Oil Co.-----	33	3	9	Kammerer 8	Richfield
California Petroleum Corp.-----	32	3	9	Bradford 7	Richfield
California Petroleum Corp.-----	33	3	9	Heartwell 3	Richfield
Continental Oil Co.-----	33	3	9	Pyne 6	Richfield
General Petroleum Corp.-----	33	3	9	Atwood 1	Richfield
Petroleum Securities Co.-----	25	3	9	Kramer 1	Richfield
Standard Oil Co.-----	34	3	9	Anaheim Union 3	Richfield
Standard Oil Co.-----	34	3	9	Moll. Comm. 2	Richfield
Standard Oil Co.-----	34	3	9	Yorba 1	Richfield
Superior Oil Co.-----	33	3	9	Etchandy 2	Richfield
Union Oil Co.-----	33	3	9	Stern 11	Richfield
Union Oil Co.-----	28	3	9	Towell 5	Richfield
Union Oil Co.-----	34	3	9	Yorba Linda	
				Group 15	Richfield
Union Oil Co.-----	34	3	9	Yorba Linda	
				Group 16	Richfield
Chas. A. Son, Trustee-----	5	5	11	Orangeana 1	-----
SAN MATEO COUNTY:					
Sequoia Oil & Gas Co.-----	13	7	5	Souza 1	-----
SANTA BARBARA COUNTY:					
Palmer Union Oil Co.-----	30	9	32	Stendel 11	Cat Canyon
R. & G. Oil Co.-----	30	9	32	8	Cat Canyon
Miley Oil Co.-----	5	4	29	Dreyfus 1	Goleta

OIL FIELD DEVELOPMENT OPERATIONS—Continued.

Company	Sec.	Twp.	Range	Well No.	Field
SANTA BARBARA COUNTY—Cont.					
Miley Oil Co.....	4	4	29	Goleta 8	Goleta
Miley Oil Co.....	3	4	29	Goleta 9	Goleta
Santa Barbara Oil Co.....	3	4	29	Hollister 3-A	Goleta
Frank Buttram.....	*	6	31	Reuben 1	-----
Henry R. Dabney.....	1	4	27	Wright 1	-----
Jay J. Rekar.....	8	4	28	1	-----
San Marcus Oil Co.....	3	6	29	1	-----
SANTA CRUZ COUNTY:					
Frank Marik.....	18	11	2	2	-----
SONOMA COUNTY:					
Shell Co.....	-----	5	6	Murphy 2	-----
VENTURA COUNTY:					
Marilou Oil Co.....	33	2	20	53	Conejo
Powell Petroleum Assn.....	33	2	20	2-P	Conejo
Trinitas Oil Co.....	33	4	18	Eureka 1	Piru
Willis W. Bryant.....	21	4	21	1	Santa Paula
Group Syndicate.....	1	4	20	1	Sespe
Oak Ridge Oil Co.....	18	3	20	Willard 23	South Mountain
Ring Petroleum Corp.....	23	3	21	1	South Mountain
Union Oil Co.....	13	3	21	Snyder 3	South Mountain
Associated Oil Co.....	22	3	23	Hartman 20	Ventura
Associated Oil Co.....	27	3	23	Lloyd 39	Ventura
Associated Oil Co.....	27	3	23	Lloyd 46	Ventura
Associated Oil Co.....	23	3	23	Lloyd 102	Ventura
General Petroleum Corp.....	21	3	23	Hisey 2	Ventura
Petroleum Securities Co.....	28	3	23	Orton 4	Ventura
Petroleum Securities Co.....	28	3	23	Orton 5	Ventura
Petroleum Securities Co.....	28	3	23	Willett 3	Ventura
Shell Co.....	28	3	23	Edison 16	Ventura
Shell Co.....	21	3	23	Edison 19	Ventura
Shell Co.....	27	3	23	Gosnell 24	Ventura
Shell Co.....	28	3	23	Gosnell 25	Ventura
Shell Co.....	28	3	23	Taylor 22	Ventura
Shell Co.....	28	3	23	Taylor 24	Ventura
Scott Petroleum Properties, Inc.....	35	4	25	Rineon 1	-----

*Rancho San Carlos de Jonata.

SPECIAL ARTICLES.

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of 'Mining in California.'

These special articles cover a wide range of subjects, both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

DEPARTMENT OF NATURAL RESOURCES ACT.

Chapter 128.

[Stats. 1927.]

An act to add a new article to chapter three of title one of part three of the Political Code, to be numbered article two j, embracing sections three hundred seventy-three to three hundred seventy-three i, relating to a department of natural resources.

[Approved by the Governor April 13, 1927.]

The people of the State of California do enact as follows:

SECTION 1. The Political Code is hereby amended by adding a new article to chapter III of title I of part III thereof, to be numbered article IIj, embracing sections 373 to 373i and to read as follows:

ARTICLE IIj.

DEPARTMENT OF NATURAL RESOURCES.

373. A department of the government of the State of California to be known as the department of natural resources is hereby created. The department shall be conducted under the control of an executive officer to be known as the director of natural resources, which office is hereby created. The director shall be appointed by and hold office at the pleasure of the governor and shall receive a salary of six thousand dollars per annum.

Except as in this article otherwise provided, the provisions of article II of this chapter, title, and part of the Political Code as adopted at the forty-fourth session of the Legislature and as the same may be amended from time to time shall govern and apply to the conduct of the department of natural resources in every respect the same as if such provisions were herein set forth at length and wherever in said article II the term "head of the department" or similar designation occurs, the same shall for the purposes of this article mean the director of natural resources.

373a. For purposes of administration the department shall be forthwith organized by the director thereof, subject to the approval of the governor, in such manner as he shall deem necessary to properly segregate and conduct the work of the department, and the director shall have power to appoint in accordance with the civil service and other provisions of law such deputies, officers and other expert and clerical assistants as may be necessary. The work of the department is hereby divided into at least four divisions to be known as the division of mines and mining, the division of forestry, the division of parks and the division of fish and game.

373b. The division of mines and mining shall be administered through a chief of division who shall also be known as the state mineralogist. He shall be appointed by the director of natural resources and shall receive a salary of six thousand dollars per annum.

373c. The division of forestry shall be administered through a chief of division who shall be known as the state forester, who shall be a technically trained forester, appointed by the director of natural resources upon nomination by the state board of forestry hereinafter provided. General policies for the guidance of the division of forestry shall be determined by a state board of forestry which shall consist of seven members appointed by and holding office at the pleasure of the governor. Of the seven members one shall be familiar with the pine timber industry, one with the redwood industry, one with the live stock industry, one with general agriculture and one with the problems of water conservation.

373d. The division of parks shall be administered through a chief of division who shall be appointed by the director of natural resources upon nomination by the state park commission hereinafter provided. General policies for the administration of the state park system shall be determined by the state park commission which is hereby created to consist of five members appointed by the governor and holding office at his pleasure.

373e. The division of fish and game shall be administered through a fish and game commission consisting of three members appointed by and holding office at the pleasure of the governor.

373f. The chiefs of the divisions of forestry and parks respectively shall receive such salaries as may be determined by the director with the approval of the governor. The director of natural resources and the chief of each division before entering upon his duties shall execute to the State of California an official bond in the penal sum of twenty-five thousand dollars conditioned upon the faithful performance of his duties. The members of the board of forestry, the state parks commission and fish and game commission shall serve without compensation, but shall be entitled to their actual expenses incurred in the performance of their duties.

373g. The department of natural resources shall succeed to and is hereby invested with all the duties, powers, purposes, responsibilities and jurisdiction of the state mining bureau, state mineralogist, department of petroleum and gas, state oil and gas supervisor, state forester, state board of forestry, California redwood park commission, San Pasqual battlefield commission, Mount Diablo park commission, state fish and game commission, state fish and game commissioners, and, except as herein otherwise provided, of the several officers, deputies and employees of such bodies and offices, and whenever by the provisions of any statute or law now in force or that may hereafter be enacted a duty or jurisdiction is imposed or authority conferred upon any of said officers, offices, bodies, deputies or employees by any statute the enforcement of which is transferred to the department, such duty, jurisdiction and authority are hereby imposed upon and transferred to the department of natural resources and the appropriate officers thereof with the same force and effect as though the title of said department of natural resources had been specifically set forth and named therein in lieu of the name of any such body, office, officer, deputy or employee. Said bodies and offices, the duties, powers, purposes, responsibilities and jurisdiction of which are so transferred and vested in the department of natural resources, and the positions of all officers, deputies and employees thereunder, are and each of them is hereby abolished and shall have no further legal existence, but the statutes and laws under which they existed and all laws prescribing their duties, powers, purposes, responsibilities and jurisdiction, together with all lawful rules and regulations established thereunder are hereby expressly continued in force.

The department of natural resources shall be in possession and control of all records, books, papers, offices, equipment, supplies, moneys, funds, appropriations, land and other property real or personal now or hereafter held for the benefit or use of said bodies, offices and officers.

The boards of district oil and gas commissioners, the offices of district oil and gas commissioners and the board of review, correction and equalization created by the act approved June 10, 1915, establishing the department of petroleum and gas, are hereby respectively continued in force with the powers, duties, responsibilities and jurisdiction in them vested by the provisions of said act approved June 10, 1915, as amended; *provided*, that said board of review shall consist of the director of natural resources, the director of finance and the chairman of the state board of equalization.

373h. The management and control of the property acquired by the State of California under or pursuant to the provisions of the act entitled "An act to accept the gift to the state of San Pasqual battlefield in San Diego county, to provide for collecting and systematizing the history of said battle, for determining the exact

location thereof, and to report a suitable method of marking said battlefield and commemorating the heroism of those Americans who fought and died there," approved May 11, 1919, is hereby transferred to and vested in the department of natural resources.

373i. From and after the date upon which this act takes effect, the department of natural resources shall be and is hereby authorized and empowered to expend the moneys in any appropriation or in any special fund in the state treasury now remaining or made available by law for the administration of the provisions of all the statutes the administration of which is committed to the department, or for the use, support, or maintenance of any board, bureau, commission, department, office or officer whose duties, powers, and functions are, by the provisions of this article, transferred to and conferred upon the department of natural resources. Such expenditures by the department shall be made in accordance with law in carrying out the purposes for which such appropriations were made or such special funds created.



ADMINISTRATIVE DIVISION.

WALTER W. BRADLEY, Deputy State Mineralogist.

Personnel.

There have been no changes of personnel to be noted during the past quarter.

Department of Natural Resources.

As one of the departments of the state government the director of which is a member of the Governor's Council, the Department of Natural Resources was created by act of the forty-seventh session of the legislature, and approved by the Governor April 13, 1927, becoming effective July 29, 1927. The work of the new department is divided at present into four divisions, comprising the Division of Mines and Mining, Division of Forestry, Division of Parks, Division of Fish and Game.

Under this statute, the State Mining Bureau created by the act of 1880 becomes the Division of Mines and Mining, of which the State Mineralogist continues as the titular head, subordinate to the Director of the Department of Natural Resources. The office of the Director is in Sacramento.

The text of the act of 1927 is given in the preceding pages.

New Publications.

During the quarterly period covered by this issue, the following Bureau publications have been made available for distribution:

Mining in California (quarterly), April, 1927, and July, 1927, being chapters 2 and 3, respectively, of State Mineralogist's Report XXIII. Price 25 cents each. Chapter 2 contains reports on the mineral resources of Amador and Solano counties; and Chapter 3, on Placer and Los Angeles counties.

Summary of Operations, California Oil Fields: Vol. 12, Nos. 9, 10, 11, March, April and May, 1927, respectively. These contain special articles on: 'Conservation of Gas in the Production of Oil,' 'Fossil Markers of Midway-Sunset-Elk Hills Region in Kern County, California,' and 'Development of the Maricopa Shale Production in the Southeastern Portion of Thirty-five Anticline, Sunset Oil Field, Kern County, California,' respectively.

Commercial Mineral Notes: Nos. 53, 54, 55, August-October (inc.). These 'notes' carry the list of 'mineral deposits wanted' and 'minerals for sale' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'Mining in California.'

Mails and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During the period covered by this quarterly report, there were 1415 letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining, and developing mineral deposits, reduction problems, marketing of refined products, and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the branches, for the many inquirers who come in for personal interviews and to consult the files and library.

DIVISION OF MINERALS AND STATISTICS.

Statistics, Museum, Laboratory.

WALTER W. BRADLEY, Deputy State Mineralogist.

STATISTICS.

Data on the 1926 production of some of California's minerals were given in both the April and July issues of MINING IN CALIFORNIA, and tabulations are presented herein showing the completed totals for all substances for that year grouped by substances and by counties. The complete, detailed annual report on the mineral production of California for 1926 is now available, as Bulletin No. 100 of the State Division of Mines and Mining.

Summary for 1926.

The total value of the mineral output of California for the year 1926 was \$450,330,856, being an increase of \$15,811,196 over the 1925 total of \$434,519,660. There were fifty-six different mineral substances, exclusive of a segregation of the various stones grouped under gems; and all of the fifty-eight counties of the state contributed to the list.

As revealed by the data following, the salient features of 1926 compared with the preceding year were: The considerable increase in value of both the petroleum and natural gas yields; and material advances also made by miscellaneous stone, zinc, cement, soda, salt, and pottery clays. Decreases were registered by gold, copper, silver, brick, granite, magnesite. There were a number of other minor variations. The net result was an increase in the grand total for all groups of nearly sixteen million dollars, as stated above. Petroleum accounted for an increase of \$14,936,848 in total value due to advanced prices, in spite of a drop from 232,492,147 barrels to 224,673,281 barrels in quantity, or a difference of 7,818,866 barrels.

Of the metals: Zinc increased from 11,546,602 pounds worth \$877,542 to 20,447,559 pounds worth \$1,533,568 due to heavy shipments of concentrates to Belgium; lead from 7,352,422 pounds and \$639,661 to 8,067,873 pounds and \$645,429. Copper decreased from 46,968,499 pounds valued at \$6,669,527 to 33,521,544 pounds and \$4,693,014; gold from \$13,065,330 to \$11,923,481; silver from 3,054,416 fine ounces worth \$2,119,765 to 2,022,460 fine ounces and \$1,262,015; quicksilver from 7683 flasks and \$621,831 to 5892 flasks and \$516,382, though the average price per flask received by the producers advanced from \$80.81 for 1925 to \$87.64 for the year 1926. Though the gold yield decreased a million dollars in value, California continues to account for approximately 30 per cent of the gold output of the United States.

Of the structural group: Miscellaneous stone advanced from \$17,409,854 to \$19,859,873 in value; cement from 13,206,630 barrels worth \$25,043,335 to 13,797,173 barrels and \$25,269,678, the average price per barrel dropping slightly. Granite dropped from a valuation of \$1,853,859 to \$655,332; brick and hollow building-blocks or tile from \$7,503,976 to \$7,026,124; magnesite from 64,623 tons, crude, valued at \$872,944 to 50,915 tons and \$587,642. Of the 'industrial' and 'salines' groups, as is usually the case, there were a number of fluctuations, the

most important increase being shown by pottery clays from 537,587 tons valued at \$674,376 to 797,461 tons and \$806,509.

By Substances.

The distribution of the 1926 output of California by substances is shown in the following tabulation:

<i>Substance</i>	<i>Amount</i>	<i>Value</i>
Barytes -----	4,978 tons	\$38,165
Bituminous rock -----	3,863 tons	21,577
Borates -----	47,605 tons	1,625,298
Brick and hollow building tile -----		7,026,124
Cement -----	13,797,173 bbls.	25,269,678
Chromite -----	395 tons	7,063
Clay (pottery) -----	797,461 tons	806,509
Coal -----	1,100 tons	5,000
Copper -----	33,521,544 lbs.	4,693,014
Dolomite -----	68,640 tons	119,313
Feldspar -----	7,300 tons	56,400
Fuller's earth -----	23,552 tons	250,192
Gems -----		9,049
Gold -----		11,923,481
Granite -----		655,332
Gypsum -----	114,868 tons	211,337
Lead -----	8,067,873 lbs.	645,429
Lime -----	63,568 tons	670,837
Limestone -----	108,795 tons	367,501
Magnesite -----	50,915 tons	587,642
Magnesium salts -----	4,881 tons	124,470
Manganese ore -----	235 tons	4,700
Marble -----	34,806 cu. ft.	119,999
Mineral paint -----	569 tons	5,846
Mineral water -----	14,074,877 gals.	1,171,550
Natural gas -----	214,549,477 M cu. ft.	19,465,347
Onyx and travertine -----	15,090 cu. ft.	7,575
Petroleum -----	224,673,281 bbls.	345,546,677
Platinum -----	306 fine oz.	32,005
Potash -----	32,884 tons	812,285
Pumice and volcanic ash -----	7,170 tons	48,350
Pyrites -----	100,896 tons	466,088
Quicksilver -----	5,892 flasks	516,382
Salt -----	311,761 tons	1,124,978
Sandstone -----	34,100 cu. ft.	17,500
Silica (sand and quartz) -----	30,010 tons	104,317
Silver -----	2,022,460 fine oz.	1,262,015
Slate -----		7,371
Soapstone and talc -----	17,004 tons	255,645
Soda -----	63,333 tons	1,305,802
Stone, miscellaneous ^a -----		19,859,873
Tungsten concentrates -----	441 tons	316,560
Zinc -----	20,447,559 lbs.	1,533,568
Unapportioned ^b -----		1,233,012
Total value -----		\$450,330,856

^a Includes macadam, ballast, rubble, riprap, sand, gravel and grinding-mill pebbles.

^b Includes antimony, asbestos, bromine, calcium chloride, diatomaceous earth, iron ore, lithia, shale oil, sillimanite-andalusite-cyanite group.

By Counties.

Distribution by counties is given in the following tabulation:

Alameda -----	\$3,158,474	Placer -----	\$480,882
Alpine -----	450	Plumas -----	3,572,628
Amador -----	2,451,500	Riverside -----	6,194,253
Butte -----	461,945	Sacramento -----	2,243,952
Calaveras -----	1,809,772	San Benito -----	2,400,850
Colusa -----	91,194	San Bernardino -----	14,218,475
Contra Costa -----	2,610,553	San Diego -----	1,241,324
Del Norte -----	70,464	San Francisco -----	112,193
El Dorado -----	302,086	San Joaquin -----	842,000
Fresno -----	6,699,928	San Luis Obispo -----	253,294
Glenn -----	58,391	San Mateo -----	1,893,853
Humboldt -----	706,670	Santa Barbara -----	2,583,548
Imperial -----	467,314	Santa Clara -----	1,028,506
Inyo -----	2,835,834	Santa Cruz -----	3,504,194
Kern -----	83,556,074	Shasta -----	2,886,144
Kings -----	720	Sierra -----	569,515
Lake -----	75,693	Siskiyou -----	494,151
Lassen -----	19,063	Solano -----	1,770,820
Los Angeles -----	194,358,926	Sonoma -----	222,586
Madera -----	425,738	Stanislaus -----	401,997
Marin -----	527,553	Sutter -----	397
Mariposa -----	319,724	Tehama -----	10,340
Mendocino -----	15,800	Trinity -----	611,797
Merced -----	192,665	Tulare -----	397,920
Modoc -----	37,991	Tuolumne -----	615,998
Mono -----	209,848	Ventura -----	30,208,369
Monterey -----	359,993	Yolo -----	20,560
Napa -----	341,571	Yuba -----	2,921,083
Nevada -----	3,240,211		
Orange -----	63,223,082	Total -----	\$450,330,856

MUSEUM.

The Museum of the State Mining Bureau possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America; and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Mining Bureau as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

LABORATORY.

FRANK SANBORN, Mineral Technologist.

A considerable number of samples of granitic rock, said to contain tin, have been received at this laboratory during the past year. These samples come from different localities in the state, from northern and southern California. Frequently a small amount of metal, said to have been reduced from the rock, is included in the sample. This metal usually proves to be an alloy of lead and tin, having a composition similar to that of tinfoil. It is generally claimed that the metal was obtained by simply crushing the rock and placing the ground material in a hot wood fire. The tin, being thus reduced, was later collected by panning the ashes.

In no case have we been able to detect any tin or lead in these samples of granitic rock. Undoubtedly, those who have submitted the samples were shown by someone how to treat the rock in order to reduce the metal. We do not know whether or not the wood used as fuel was secretly treated beforehand by the same instructor.

A total of 1117 samples were received and determined at the laboratory during the three-month period covered by this report. Many of these samples were of minerals having commercial possibilities, provided they were from deposits of sufficient size.



LIBRARY.

E. A. LOWE, Librarian.

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines and Mining contains some five thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, 'Mining in California' contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED.

Governmental.

U. S. Geological Survey :

- Bulletin 792-C. The Toklet-Tonzona Region. By Stephen R. Capps. Investigations in Northern Alaska. By Philip S. Smith.
- Bulletin 796-A. The Gillette Coal Field Northwest of Wyoming. By C. E. Gibbon and B. R. Barnett. With a chapter on the Minturn District and the northwestern part of the Gillette Field. By W. T. Thom, Jr.
- Prof. Paper 149. Correlation of Geologic Formations between East-Central Colorado, Central Wyoming and Southern Montana. By Willis T. Lee.
- Water Supply Paper 566. Surface Water Supply of the United States, 1923. Part 6—Missouri River Basin.
- Water Supply Paper 570. Surface Water Supply of the United States, 1923. Part 10—The Great Basin.
- Water Supply Paper 596-C. Ground Water in the Ordovician Rocks near Woodstock, Va. By Geo. M. Hall.
- Water Supply Paper 596-D. Quality of Water of Pecos River in Texas. By W. D. Collins, and H. B. Riffenburg.

U. S. Bureau of Mines :

- Technical Paper 415. The Function of Steam in Lime Kiln. By Ernest E. Berger.
- Technical Paper No. 426. Production of Explosives in the United States during 1926, with Notes on Mine Accidents Due to Explosives. By Wm. W. Adams.
- Mineral Resources of the United States. 1926. Preliminary Summary. Introduction by Frank H. Katz. Statistics assembled by Martha B. Clark.
- Graphite in 1925.
- Carbon Black Produced from Natural Gas in 1925.
- Feldspar in 1925.

Asphalt and Related Bitumens in 1925.
 Gold, Silver, Copper, Lead and Zinc in Montana in 1925.
 Platinum and Allied Metals in 1926.
 Selenium and Tellurium in 1926.
 Gold, Silver, Copper, Lead and Zinc in Nevada in 1925.
 Carbon Black Produced from Natural Gas in 1926.
 Bauxite and Aluminum in 1926.
 Fluorspar and Cryolite in 1926.
 Mica in 1925.
 Barite and Barium Products in 1926.
 Selenium and Tellurium in 1926.
 Gold, Silver, Copper and Zinc in the Eastern States in 1926.
 Arsenic in 1926.
 Salt, Bromide and Calcium Chloride in 1926.
 Platinum and Allied Metals in 1926.
 Tin in 1926.
 Asphalt and Related Bitumens in 1926.
 Antimony in 1926.
 Bauxite and Aluminum in 1926.
 Gold, Silver, Copper, Lead and Zinc in Colorado in 1926.

Reports of Investigations :

Serial No. :

- 2805—Known Accumulation of Gas Ignited by Unapproved Rock-Dusting Machine. By L. D. Tracy and C. W. Owings.
- 2806—The Interpretation of Crude Oil Analyses. By N. A. C. Smith.
- 2807—Properties of Typical Crude Oils From the Producing Fields of Venezuela. By A. J. Kraemer.
- 2808—Analyses of Spindletop, Texas, Crude Oils. By A. J. Kraemer and Peter Grandone.
- 2809—Coal Mine Fatalities in April, 1927. By W. W. Adams.
- 2810—Consumption of Explosives in April, 1927. By W. W. Adams.
- 2817—Desulphurizing Action of Manganese in Iron. By C. H. Herty, Jr., and J. M. Gaines, Jr.
- 2818—Permissible Explosives Approved Prior to June 30, 1927. By G. St. J. Perrott and S. P. Howell.
- 2819—Apparatus for Vacuum Distillation of Lubricating and Heavy Petroleum Oils. By Martin J. Gavin and Arch. L. Foster.
- 2820—The Wire Saw in Slate Quarrying. Preliminary Report. By Oliver Bowles.
- 2821—Coal Mine Fatalities in June, 1927. By W. W. Adams.
- 2822—The Use of Solvents for Dewaxing Paraffin Base Crude Oil. By H. M. Smith.
- 2823—Consumption of Explosives in June, 1927. By W. W. Adams.
- 2824—Analyses of Crude Oils From the Seminole District, Oklahoma. By A. J. Kraemer.
- 2825—Coal Mine Fatalities in July, 1927. By W. W. Adams.
- 2826—Consumption of Explosives in July, 1927. By W. W. Adams.
- 2827—Sixteenth Semi-Annual Motor Gasoline Survey. By E. C. Lane, D. J. Condit, and C. S. Luce.
- 2828—The Detection of Sulphur in Petroleum and Petroleum Distillates. By F. W. Lane and John M. Devine.
- 2829—Progress of Fuel Economy at Petroleum Refineries in the United States. By G. R. Hopkins.
- 2830—Coal Mine Fatalities in August, 1927. By W. W. Adams.
- 2831—Consumption of Explosives in August, 1927. By W. W. Adams.

Information Circulars :

- Circular No. 6036—Questions and Answers on Bureau of Mines Approvals of Electrical Equipment.
- Circular No. 6037—One Hundred and One Questions on Electrical Inspection In and About Mines.
- Circular No. 6045—Coal Mine Safety Organization.
- Circular No. 6046—Wanted: More Detailed Reports on Electrical Accidents. By L. C. Ilsley.
- Circular No. 6047—List of Permissible Mining Equipment.

- Circular No. 6048—Instructions for Sampling Atmospheric Dust by the Impinger Method. By Alden H. Emery.
- U. S. Coast and Geodetic Survey: Progress of Seismological Investigations in the United States, January 1, 1925, to June 30, 1927. By N. H. Heck.
- U. S. National Museum: Proceedings, Vol. 72—Heretofore Undescribed Meteoric Irons from
1. Bolivia, South America.
 2. West Arkansas.
 3. Seneca Township, Michigan.
- By Geo. P. Merrill.
- Vol. 1—The Recently Found Iron Meteorite from Oakley, Idaho. By Geo. P. Merrill.
- California Academy of Science: Proceedings, 4th Series, Vol. 14, No. 19: Paleontology of the Miocene of Lower California. By Leo Geo. Hertlein and Harry Knight Jordan.
- Connecticut State Geological and Natural History Survey: Bulletin 39—Guide to the Insects of Connecticut. Part V. The Odonata or Dragon Flies of Connecticut. By Philip Garman.
- Idaho Bureau of Mines and Geology:
- Pamphlet 18. Some Miocene and Pleistocene Drainage Changes in North Idaho. By Alfred H. Anderson.
- Pamphlet 21. The Vienna District, Blaine Co., Idaho. By Clyde T. Ross.
- Pamphlet 22. Ore Deposits in Tertiary Lava in the Salmon River Mountains, Idaho. By Clyde P. Ross.
- Pamphlet 24. Underground Water Resources in the Vicinity of Oro Vino, Idaho, and Lapwai, Idaho. By Virgil P. D. Kirkham.
- Illinois Department of Registration and Education, Division of the State Geological Survey: Petroleum No. 11. Recent Developments in the Vicinity of Jacksonville. By Alfred H. Bell.
- Petroleum No. 12.
- Kentucky Geological Survey:
- Geology of the Island Creek Oil Pool. By Willard Rouse Jillson.
- Geology of the Oil Shales of Eastern United States. By Willard Rouse Jillson.
- Geology of the Pennyroyal. A Study of the Influence of Geology and physiography upon the Industry, Commerce and Life of the People. By Carl Ortwin Sauer.
- North Carolina Department of Conservation and Development: Conservation Laws of North Carolina, July, 1927.
- Oklahoma Geological Survey: Bulletin 35. Index to the Stratigraphy of Oklahoma. By Chas. N. Gould.
- San Diego Society of Natural History:
- Vol. II, No. 1. A Preliminary List of the Hemipters of San Diego County. By E. P. Van Duzee.
- No. 2. The Variation Exhibited by *Ancistrodon halys* (Pallas). By Joseph C. Thompson.
- No. 3.
- Vol. III, No. 1. Palaeozoic Crustacea. By Anthony Wayne Vogdes.
- No. 2.
- No. 3.
- No. 4.
- Vol. IV, No. 1. Part I—Bibliography of Palaeozoic Crustacea.
Part II—List of the Genera and Subgenera of the Trilobita.
Part III—Historical Summary of the Ordovician Genus *Cybele* Loven. By Anthony Wayne Vogdes.
- Vol. V, No. 1.
- No. 2.
- No. 3. The New Geometridae from San Diego County, California. By William S. Wright.
- No. 4. Foraminifera from the Eocene near San Diego, California. By Joseph A. Cushman and Marcus A. Hanna.
- No. 5.
- No. 6. Late Tertiary and Quaternary Elphidiums of the West Coast, North America. By Joseph A. Cushman and U. S. Grant, IV.
- No. 7.

- South Dakota School of Mines: Bulletin 15—The Tertiary Mineralization of the Northern Black Hills. By Jos. P. Connolly.
- Virginia State Chamber of Commerce: Minerals of Virginia, Their Appearance and Uses. Document No. 1.
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- Argentina Ministerio de Agricultura de la Nacion:
- Publicacion No. 29. Production de Petroleo, en la Republica Argentina durante el Ano 1926.
- Publicacion No. 31. Las Minas del Fraile y Sierra de Zapata. By Sven Wassman.
- Publicacion No. 32. Los Estratos con Dinosaurios y su Techo.
- Publicacion No. 33. Resultados de un Viaje de Estudios Geologicos en los Territorios del Rio Negro y del Chubuit. By Ricardo Wickmann.
- Publicacion No. 30. Sobre las Minas de Estano en la Region del Fraile y Sierra de Zapata. By N. A. Lannefors.
- Barcelona Real Academia de Ciencias y Artes:
- Memorias de la Vol. XX, Num. 5. Metodos Modernos de Mejora y Obtension de Variedades de Plantas.
- Vol. XX, Num. 6. Las Exploraciones Arqueologicas en Creta e Interes de los Ultimos Descubrimientos.
- Summario, Vol. V, Num. 4.
- Vol. XX, Num. 2. El Principio de Contradiccion en la Geometria no Euclidea y en el Principio de Relatividad. By D. Jose Tous y Biaggi.
- Vol. XX, Num. 3. Monografia de los Bombylidos de las Islas Canarias. By Dr. D. Elias Santos Abreu.
- Vol. XX, Num. 4. La Flora de las Pitiusas y sus Afinidades con la de la Peninsula Iberica.
- Canada Department of Mines:
- Abrasives Products of Canada, Technology and Application, Part I. Siliceous Abrasives. By V. L. Eardley-Wilmot.
- Use of Alberta Bituminous Sands for Surfacing of Highways. By S. C. Ells.
- Memoir 152. St. Urbain Area, Charlevoix District, Quebec. By J. B. Mawdsley.
- Memoir 151. Mino Coal Basin, New Brunswick. By W. S. Dyer.
- Summary Report, 1925, Part C.
- Summary Report, 1926, Part B.
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- Canadian Mining and Metallurgical Bulletin No. 185.
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- The Geology of the Country Around Wrexham. By C. B. Wedd, B. Smith and L. J. Wills.
- Manchuria Geological and Mining Review, No. 68.
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- Bulletin 61. Mineral Production of Ontario, January to June, 1927.
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- Scotland Geological Survey: Memoirs. The Oil Shales of the Lothians.
- South Australia, Transactions and Proceedings of, Vol. L.
- Transvaal Chamber of Mines, 1926. The Wage Position of the Witwatersrand Gold Mine.
37th Annual Report for the year 1926.
- Victoria Geological Survey, Department of Mines: Bulletins of the Geological Survey 149. Some Mines of Maldon. By J. J. Caldwell, H. S. Whitelaw and D. J. Mahoney.
- Western Australia Geological Survey:
Bulletin 85. The Geological Reconnaissance of Part of the Ashburton Drainage Basin, with Notes on the Country Southwards to Meekatharra. By H. W. D. Talbot.
Bulletin 93. The Geology of Portions of the Kimberley Division, with Special Reference to the Fitzroy Basin and the Possibilities of Occurrence of Mineral Oil. By T. Blatchford.
Bulletin 87. A Geological Reconnaissance in the Central and Eastern Divisions. By H. W. D. Talbot.
- American Mineralogist, Journal of the Mineralogical Society of America, Vol. 12, No. 10, Oct. 1927.
- Economic Geology, Vol. 22, No. 6, September-October, 1927.
- Engineers Society of Western Pennsylvania, Proceedings of;
Vol. 43, No. 5.
Vol. 43, No. 4.
- Institution of Mining and Metallurgy, Transactions of, 35th Session, 1925-1926, Vol. 35.
Bulletin 275, September, 1927.
- Smithsonian Institution, Annual Report of, 1926.
- Western Society of Engineers, Journal of, September, 1927,
Vol. 32, No. 8.
Vol. 32, No. 6, Part II.

Maps.

Topographic Maps:

- New Martinsville, W. Va.-Ohio.
Holbrook, W. Va.
Pinckneyville, Ill.
Roodhouse, Ill.
Weston, W. Va.
Parsons, W. Va.
Ivanhoe, California.
Griggsville, Ill.
Draper, Va.-N. C.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

- American Petroleum Institute, New York.
Architect and Engineer, San Francisco.
Arizona Mining Journal, Phoenix, Arizona.
Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.

Bulletin, Union Oil Co., Los Angeles.
 California Journal of Development, San Francisco.
 Cement, Mill and Quarry, Chicago, Illinois.
 Chemical-Engineering and Mining Review, Melbourne, Australia.
 Engineering and Mining Journal, New York.
 Explosives Engineer, Wilmington, Del.
 Financial Insurance News, Los Angeles, California.
 Graphite, Jersey City.
 Journal of Electricity and Western Industry, San Francisco.
 Metallurgical and Chemical Engineering, New York.
 Mine and Quarry, Chicago.
 Mining and Engineering Record, Vancouver, B. C.
 Mining and Oil Bulletin, Los Angeles.
 Oil Age, Los Angeles.
 Oil and Gas Journal, Tulsa, Oklahoma.
 Oil and Gas News, Kansas City.
 Oil News, Galesburg, Illinois.
 Oildom, New York.
 Oil, Paint and Drug Reporter, New York.
 Oil Trade Journal, New York.
 Oil Weekly, Houston, Texas.
 Petroleum Age, New York.
 Petroleum Record, Los Angeles.
 Petroleum World, Los Angeles.
 Queensland Government Mining Journal, Brisbane, Australia.
 Rock Products, Chicago, Illinois.
 Safety News, Industrial Accident Commission, San Francisco.
 Salt Lake Mining Review, Salt Lake City, Utah.
 Southwest Builder and Contractor, Los Angeles.
 Standard Oil Bulletin, San Francisco.
 Stone, New York.
 The Record, Associated Oil Company, San Francisco.
 Through the Ages, Baltimore.

Newspapers.

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, Cal.
 Arkansas Oil and Mineral News, Hot Springs National Park (Arkansas).
 Barstow Printer, Barstow, Cal.
 Blythe Herald, Blythe, Cal.
 Bridgeport Chronicle-Union, Bridgeport, Mono Co., Cal.
 Calaveras Prospect, San Andreas, Cal.
 California Oil World, Los Angeles, Cal.
 Cloverdale Reveille, Cloverdale, Cal.
 Colusa Daily Sun, Colusa, Cal.
 Daily Commercial News, San Francisco, Cal.
 Daily Midway Driller, Taft, Cal.
 Del Norte Triplicate, Crescent City, Cal.
 Exeter Sun, Exeter, Cal.
 Gateway Gazette, Beaumont, Cal.
 Goldfield News, Goldfield, Nevada.
 Guerneville Times, Guerneville, Cal.
 Healdsburg Enterprise, Healdsburg, Cal.
 Humboldt Standard, Eureka, Cal.
 Inyo Independent, Independence, Cal.
 Inyo Register, Bishop, Cal.
 Ione Valley Echo, Ione, Cal.
 Lake County Bee, Lakeport, Cal.
 Mining and Financial Record, Denver, Colo.
 Mining Topics, San Francisco, Cal.
 Mountain Democrat, Placerville, Cal.
 Mountain Messenger, Downieville, Cal.
 Nevada Mining Press, Reno, Nevada.
 Oatman Mining News, Oatman, Arizona.

Oregon Observer, Grants Pass, Oregon.
Oroville Daily Register, Oroville, Cal.
Petroleum Reporter, Taft, Cal.
Placer Herald, Auburn, Cal.
Plumas Independent, Quincy, Cal.
Plumas National Bulletin, Quincy, Cal.
Randsburg Times, Randsburg, Cal.
San Diego News, San Diego, Cal.
Shasta Courier, Redding, Cal.
Siskiyou News, Yreka, Cal.
Stockton Record, Stockton, Cal.
Tuolumne Prospector, Tuolumne, Cal.
Ventura Daily Post, Ventura, Cal.
Weekly Trinity Journal, Weaverville, Cal.
Western Sentinel, Etna Mills, Cal.



PRODUCERS AND CONSUMERS.

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of MINING IN CALIFORNIA, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list for MINING IN CALIFORNIA.



EMPLOYMENT SERVICE.

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature, only are registered, as no attempt will be made to supply common mine and mill labor.

A list of current applications for positions and 'positions open' is carried in each issue. Notices are designated by a key number, and the name and address corresponding to any number will be supplied upon request, without delay or charge of any kind. If desired, recommendations may be filed with an application, but copies only should be sent to the Division of Mines and Mining, to avoid possible loss. Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded.

POSITIONS WANTED.

- 51-12 Assayer-Accountant. Eighteen years' experience, Mother Lode mines. Widower. Salary open.
- 51-13 Chemist. Six years' experience. Age 25. Single. References. Salary wanted, \$140-\$150.
- 51-14 Draftsman-Instrument Man. Twenty years' general experience, R. R., etc. Salary open.
- 51-15 Flotation Operator or Mill Shift Boss. Graduate mining engineer. Seven years' experience. Age 32. Single. References. Salary wanted, \$175.
- 51-16 Mine Manager. University graduate. Twenty-five years' experience, foreign and domestic. Age 44. Married. References. Salary wanted, \$350-\$450 per month.
- 51-17 Examinations, Mine Management, Superintendent or Assayer. Twenty-two years' experience. Read, write and speak Spanish fluently. Age 47. Married. References. Salary open.
- 51-18 Surveying, Mill Construction, Mine Superintendent. Over twenty years' foreign and domestic experience. Speaks Spanish fluently. Age 45. Married. Reference. Salary open.

PUBLICATIONS OF THE DIVISION OF MINES AND MINING.

During the past forty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the state, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the office of the Division of Mines and Mining, in the Ferry Building, San Francisco; New Orpheum Building, Los Angeles; Chamber of Commerce Building, Sacramento; Santa Maria; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states, and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the Division of Mines and Mining.

REPORTS.

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	-----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	-----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks-----	-----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks-----	-----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks-----	-----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	-----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	-----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. -----	-----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	-----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	-----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	-----

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.-----	\$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford-----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford-----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper-----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper-----	.50
Mines and Mineral Resources, Del Norte, Humboldt, and Mendocino Counties, 59 pp., paper-----	.25
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper-----	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper-----	.35
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper-----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou, and Trinity Counties, 974 pp., 275 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper-----	----
**Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter, and Tehama Counties, 91 pp., paper-----	----
Mines and Mineral Resources, El Dorado, Placer, Sacramento, and Yuba Counties, 198 pp., paper-----	.65
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties, 183 pp., paper-----	.65
Mines and Mineral Resources, Los Angeles, Orange, and Riverside Counties, 136 pp., paper-----	.50
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper-----	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report, Biennial Period 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper-----	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper-----	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper-----	.50
Seventeenth Report of the State Mineralogist, 1920, Mining in California during 1920, Fletcher Hamilton: 562 pp., 71 illustrations, cloth-----	1.75

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

Price

Eighteenth Report of the State Mineralogist, 1922, Mining in California, Fletcher Hamilton. Chapters published monthly beginning with January, 1922:

**January, **February, March, April, May, June, July, August, September, October, November, December, 1922----- Free

Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 ----- Free

Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy----- \$0.25

Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange counties----- .25

April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura counties----- .25

July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego counties ----- .25

October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara counties----- .25

Subscription, \$1.00 in advance (by calendar year, only).

Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz counties ----- .25

April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial counties ----- .25

July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties-- .25

October, 1926, Mines and Mineral Resources of El Dorado and Inyo counties, also report on Minaret District, Madera County----- .25

Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly.

January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island----- .25

April, 1927, Mines and Mineral Resources of Amador and Solano counties-- .25

July, 1927, Mines and Mineral Resources of Placer and Los Angeles counties .25

Chapters of State Oil and Gas Supervisor's Report:

Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume) ----- Free

Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:

**April, **May, June, **July, **August, **September, **October, November, **December, 1919 ----- Free

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January, February, March, April, May, June, July, August, September, October, November, December, 1923----- Free

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January, February, March, April, May, June, July, August, September, October, November, December, 1926----- Free

January, 1927 ----- Free

BULLETINS.

Asterisks (**) indicate the publication is out of print.		Price
**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations-----		-----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations-----		-----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps-----		-----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)-----		-----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations-----		-----
Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations-----		\$0.50
**Bulletin No. 7. Mineral Production of California, by Counties for the year 1894, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 8. Mineral Production of California, by Counties for the year 1895, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations-----		-----
**Bulletin No. 10. A bibliography Relating to the Geology, Palæontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.-----		-----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations-----		-----
**Bulletin No. 12. Mineral Production of California, by Counties for 1896, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 13. Mineral Production of California, by Counties for 1897, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 14. Mineral Production of California, by Counties for 1898, by Charles G. Yale-----		-----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899-----		-----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations-----		-----
**Bulletin No. 17. Mineral Production of California, by Counties for 1899, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations-----		-----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps-----		-----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899-----		-----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet-----		-----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet-----		-----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, and 9 maps-----		.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps-----		-----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 26. Mineral Production of California for the past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet-----		-----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps-----		-----
**Bulletin No. 28. Mineral Production of California, for 1902, by Charles G. Yale. Tabulated sheet-----		-----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet-----		-----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.		Price
**Bulletin No. 30. Bibliography Relating to the Geology, Palæontology, and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.-----		----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet-----		----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps-----		----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet-----		----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California-----		----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905, 120 pp., 66 illustrations, 3 maps-----		----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations-----		----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map-----		----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet-----		----
**Bulletin No. 41. Mines and Minerals of California, for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps-----		----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps-----		----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.-----		----
Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.-----		\$0.30
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet-----		----
**Bulletin No. 48. Mineral Production of California for Twenty Years. 1906, by Charles G. Yale-----		----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.-----		----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman, 366 pp., 74 illustrations. (Revised edition.)-----		1.00
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet-----		----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, 1907, by D. H. Walker. Tabulated sheet-----		----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker, 62 pp.-----		----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet-----		----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet-----		----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker. 78 pp.-----		----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations and 10 maps-----		----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker, 1909. Tabulated sheet-----		----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker, 1909. Tabulated sheet-----		----

BULLETINS—Continued.

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**Bulletin No. 60. Mineral Production for 1909, County Maps and Mining Laws of California, by D. H. Walker. 94 pp.	-----	-----
**Bulletin No. 61. Mineral Production of California, by Counties for 1910, by D. H. Walker. Tabulated sheet.	-----	-----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker, 1910. Tabulated sheet.	-----	-----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps.	-----	-----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.	-----	-----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.	-----	-----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp.	-----	-----
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp.	-----	-----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.	-----	-----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]	-----	-----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.	-----	-----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp., 4 illustrations.	-----	-----
Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.	-----	\$0.25
**Reconnaissance Geologic Map (of which Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch = 12 miles. Mounted.	-----	-----
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the fiscal year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations.	-----	-----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations.	-----	Free
**Bulletin No. 75. United States and California Mining Laws, 1917. 115 pp., paper	-----	-----
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**Register of Mines, with Map, Butte County -----	----
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**Register of Mines, with Map, El Dorado County-----	----
**Register of Mines, with Map, Inyo County -----	----
**Register of Mines, with Map, Kern County -----	----
**Register of Mines, with Map, Lake County -----	----
**Register of Mines, with Map, Mariposa County -----	----
**Register of Mines, with Map, Nevada County -----	----
**Register of Mines, with Map, Placer County -----	----
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OIL FIELD MAPS.

These maps are revised from time to time as development work advances and ownerships change.

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Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County -----	.75
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Map No. 29—Dominguez, Los Angeles County-----	.75
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DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Division of Mines and Mining for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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